NATURAL RESOURCES OF THE ANDHRA AREA

AND

ALLIED TOPICS

A SYMPOSIUM OF PAPERS

READ BEFORE

THE INDIAN ACADEMY OF SCIENCES

SIXTH ANNUAL SESSION (1940)

WALTAIR.

THE ANDHRA UNIVERSITY,

GUNTUR (INDIA).

PREFACE.

THE Indian Academy of Sciences met in December 1940 for its sixth annual session, at Waltair under the auspices of the Andhra University. On that occasion, a Symposium on the 'Natural Resources of the Andhra Area and Allied Topics' was held. A number of eminent scientists took part in the discussions. The Faunal, Floral, Mineralogical, Electrical and Chemical resources of the Andhra Desa and the scope they provide for the industrial development of the area were clearly put forward. The University at once realised the urgent necessity of placing this information on record and undertook to publish the Symposium. Due to the conditions of war, the publication could not be brought out earlier. It is hoped that this pamphlet will be of real service to the Andhra public and help to promote industrial development in the Andhra Area.

The executive committee takes this opportunity of thanking the various authors who have kindly contributed to the success of this Symposium.

The details of arranging the matter, giving instructions to the Press regarding the get up and so on, correcting proofs at various stages and other editorial scrutiny required for securing uniformity in the diverse papers that have gone to make up the Symposium have been in the hands of Mr. J. Bhimasenachar, M. Sc., and the thanks of the executive committee are due to him for the able manner in which he has seen to the completion of the above work.

S. BHAGAVANTAM,
Secretary, Executive Committee,
Sixth Annual Session,
The Indian Academy of Sciences.

CONTENTS.

CHAPTER I.

FAUNA.*

BY

DR. H. SRINIVASA RAO, D.Sc., F.A.Sc.

(*Zoological Survey of India, Calcutta.*)

The conservation of the natural resources of the world is a fundamental problem of the human race. Few will question the fact that no civilised life can be developed or maintained without abundant natural resources. Forests, lands, waters, and minerals are rightly regarded as the sources of economic wealth, but the part that the fauna of a country plays in its economic development is often overlooked even by many advanced nations, not to speak of politically and economically undeveloped India. It is therefore of considerable significance that in the symposium on the Natural Resources of the Andhra area sponsored by the Andhra University the fauna is privileged to occupy an important place among the five chief sources of material wealth.

For many thousands of years man has been surrounded by animals in his native haunts, in the cave dwellings and forests at first, in his nomadic life as in his agricultural settlements, and later in his rural and urban homes. Apart from the fact that he has consciously pressed them into his service in manifold ways, there is an unseen role which animals play in every

*Published with the permission of the Director, Zoological Survey of India.

type of environment in which man has accustomed himself to live. This may result in harm or benefit to him according as he has hindered or aided Nature in the establishment of a "balance of life". A complex system of checks and balances in Nature is always operating, but this is neither fixed nor ordained. Throughout the civilised world man has so profoundly disturbed Nature's equilibrium that he must ultimately assume effective and intelligent control of all animal life within his orbit of influence, utilising as far as possible natural enemies of injurious forms of life, but keeping them under his direction and supplementing them by all the various artificial agencies at his command. If civilised man is to undertake this task successfully, he must be well-equipped with a thorough knowledge of his biological environment.

The physical features of the Andhra area are as varied as they are in India as a whole, and the types of environments present in them are therefore suitable for the occurrence of a large variety of fauna. But as no systematic survey of the fauna of the area has ever been made, our recorded knowledge of it is very poor. The little knowledge that we possess we owe to the desultory surveys of the seas and backwaters, the rivers and lakes, and the hills and forests by individuals with a scientific bent of mind like Drs. Patrick Russel and Francis Day, by scientific societies like the Bombay Natural History Society, and by Government institutions such as the Marine Survey of India, the Zoological Survey of India, and the Madras Fisheries, Agricultural, Medical and Veterinary and Forest Departments. Their recorded findings are to be found in widely scattered

publications. The material for the present symposium having been culled from these sources, it must be admitted that the account of the fauna of the Andhra area is neither complete nor satisfactory. Nevertheless, a full description of the fauna known hitherto would take up more space than is available for the present symposium.

The Andhra area consists of the five maritime districts—Vizagapatam. Godavari, Kistna, Guntur and Nellore, and of the four interior districts—Cuddapah, Kurnool, Anantapur and Bellary which are collectively known as the Ceded districts or Rayalaseema. In the forests and sub-montane tracts, in the abodes of civilised man and in his fields and factories, and in the lakes, rivers, estuaries, backwaters, and the coastal waters, the composition of the fauna varies within wide limits. Although precise knowledge of the fauna of the districts named is wanting. it is possible to estimate the approximate composition of the animal communities in the various types of environment from what is already known of the fauna in the rest of India with more or less similar physical features and climate.

There are more than 500 species of mammals known from India of which only a 100 are recorded from the Andhra area. Nor do the species of reptiles recorded from this area exceed this number. Of the frogs and toads, the number of species known is less than 50. Many species of birds are common to the Andhra country and the rest of India, but a recent survey of the Eastern Ghats within the Andhra area by the Bombay Natural History Society revealed the occurrence of

several interesting birds. More than 600 species of marine and 90 species of freshwater fish are known to occur, but a more intensive survey in the area would bring to light many other hitherto unrecorded forms. Of insects and their allies no estimate can be formed as yet of the number of species occurring in the Andhra region, but the 160 and odd species of forest trees and cultivated plants alone have as pests on them over 500 species of insects.

As no useful purpose will be served by giving a numerical estimate of the animal species which are known to occur in the area under consideration, only such elements of the fauna as have been proved to be of some economic value are dealt with in the following paragraphs.

The cattle wealth of the Andhra region may be reckoned as the most important. The Ongole breed of cattle known all over the world, the Krishna Valley breed of the black cotton soil of the Ceded Districts, the Dupād and Erramalā breeds of Kurnool, the buffaloes of Vizagapatam and the Agency tracts and the sheep of Nellore, Bellary and Godavari, and the bison of the Pāpikonda range north of the Kistna river constitute one of the richest sources of wealth in the Andhra country. The Ongole breed of cattle are known to be the best milkers in the Madras Presidency and calve every year. They were at one time extensively exported to tropical America to improve the local breed. Herds of pure-bred Ongole are now maintained to provide sires for grading up local stock of European origin. They are resistant to tick-borne diseases, thrive on scanty dry fodder, and

are efficient for work under heavy ploughs or carts. They are, however, unsuitable for speed. The average yield of milk per lactation has been computed at 3,500 pounds, but cases where the yield has reached over 7,000 pounds are also known.

Cattle hides and sheep and goat skins are the main sources of raw material for leather. The pig furnishes a high quality of tough and durable leather suitable for saddles, shoes, gloves and travelling cases. The average annual value of tanned hides and skins exported from India for the three year period ending 1939-40 was six crores and six lakhs of Rupees. There are no means of computing what proportion of this sum is contributed by the Andhra area. The slaughter-house bones of cattle, goats and sheep may be utilised for obtaining grease which in its refined form is used in the manufacture of soap, glycerine, candles, explosives etc. Glue made from the bones after extraction of grease is used in the production of aeroplanes, ships, shell-cases, and fire-resisting paints Finally the residual bones are ground down to make fertilizers for crops, or calcined by burning to make China Bone-meal is also used as pig and poultry food. The ornamental work for which bison horn is used in the Vizagapatam district is also well-known. Beef and marrow are used for making tallow and edible fat. The gut of sheep is used for making violin strings and surgical gut, while the gall and blood serum of oxen are used in pharmacy. In sugar refining and in wood work black blood albumen is largely used. The wealth that cattle alone contribute to India may run to several hundred crores of Rupees,

and the share of the Andhra region with its famous breeds of cattle may not be inconsiderable.

The fur of rabbits and hares if properly bred can be made into cheap commercial furs. In the waste lands among grass and bushes south of the Godavari river two species of hares occur of which one is edible. There is at present little evidence that they are put to any use at all except by the poorer classes of people. The quills of porcupines which live in caves, in burrows of hill sides and of river banks are also put to some little ornamental use in the Godavari and Vizagapatam districts, but there does not seem to be any extensive demand for these quills outside the Andhra area.

A regular export trade in bird-skins seems to have existed in the region of the Colair lake in West Godavari district several years ago, but the depletion of birds by constant wreckless shooting is said to have killed this trade. The lake may easily be made a bird sanctuary with a view to revive the trade in these skins. The large extent of the lake (100 sq. miles) and its situation between the Godavari and the Kistna deltas and near the sea are most favourable for this purpose, and a great variety of aquatic birds may find it a convenient wintering centre if adequate protection is given to them by careful legislation. The bile of the peacock is said to be used as a medicine in this country.

The aquatic resources of the Andhra area in respect of its fauna are even more important than those of the terrestrial regions. Fish and other aquatic animals are available in adequate quantities along the coasts and in

the rivers and its estuaries, in backwaters and in tanks and lakes. Most of them are edible, and the average rural and urban populations are not usually averse to a diet of animal foods when they can be had cheaply and in abundance. The Andhra country, as is well-known, has a sea-board of over 500 miles, and two large perennial rivers, the Kistna and the Godavari, with extensive estuarine and backwater tracts. The enormous quantities of silt and organic detritus brought down by these rivers consist of dissolved nitrogenous compounds, mineral salts, and carbonic acid which promote the growth of abundant microscopic organisms in the Andhra littoral aided by the warmth of the tropical sun; and these organisms form the food of fish and other aquatic animals. We know practically nothing of the lives of these fish, and our fishermen, poor, ignorant and unorganised, have no means of employing efficient engines of capture in the more fertile regions of the sea where fish may be expected to occur in variety and abundance. Nor are they acquainted with the best methods of preserving fish when they occur in great abundance and cannot all be sold in the fresh condition. In advanced countries fish which cannot be eaten fresh are preserved by freezing, canning, salting, pickling, smoking, sun-drying, and sometimes even by fermenting, but the primitive methods of preservation followed in the Andhra country as in the rest of India make the preserved products unsaleable as edible commodities. There are several species of fish which are not relished as food by the majority of people among which may be included the sharks, rays, and saw-fish, but they are used for making fish-oil, fish-meal or guano, and

fertilisers. Hydrogenated fish-oil finds its use in soap manufacture while shark-oil is used in medicine. The shark and saw-fish liver oils which, since the commencement of the present war, are being increasingly extracted on the Andhra coast are reputed to be much richer in Vitamin A content than Cod-liver oil, or almost equal in quality and potency to the Halibut liver oil. The value of the Indian fish-liver oils as a medicine has been known in India for many years, and in the sixties of the last century Madras alone exported fish-oil worth two lakhs of Rupees. When in 1870 the cost of Cod-liver oil fell below that of Indian fish-liver oils, the oil-extracting industry in India languished as a result of its inability to stand the competition of imported oils. The present war has come as a blessing in disguise for the Indian fish-liver oil, and with proper organisation and Government support the fish-oil industry is bound to stand on its feet once again.

Apart from their value as food and medicine fish, can be utilised in various other ways. The skin and swim-bladders of some fish are used for clarifying beer and in the manufacture of isinglass The skins and other waste matter of fish are utilised in the manufacture of glue. The skins of sharks and their allies make excellent leather when tanned. Shark-fins are highly prized by the Chinese for their soup, and this fact is so well-known to Indian fishermen that no shark caught is thrown into the sea without the fins being removed and preserved. The scales of certain fish like the Shad are used in Europe and America in the manufacture of pearl essence. The possibility of utilising the scales of the larger forms of fish like the Hilsa and the

Mahseer for the same purpose remains to be explored. Fish-bile is said to have been used chemically in India, and the large fish-scales of the Great Mahseer of our hill-streams and the upper reaches of rivers are reputed to be used in the manufacture of playing cards in this country.

The coastal waters including the estuaries and the backwaters of the Andhra area are rich in shell-fish of various kinds amongst which the best known are the prawns, lobsters, and crabs, and the oysters, clams, cockles, and mussels. The flesh of prawns and their allies has a high percentage of protein and soluble fat and is therefore a valuable nutritious food, while their shells in powdered or "bran" form may be used as food for farm animals such as poultry and pigs. The prawn, crab, and lobster industry on the Andhra coast does not seem to be as important as on the west coast of India where there is a valuable export trade of prawn shells, but the general physical and biological conditions on the Andhra coast more particularly in the Godavari and Kistna estuaries not being unsimilar to those of the west coast the development of this industry is well within the range of possibility. Many species of edible prawns and crabs have been recorded from this coast.

The flesh of molluscan shell-fish is of no less value as food than that of fish *sensu stricto* or of the crustacean shell-fish. It contains large quantities of glycogen, fat and salts which make it specially nutritious and easily digestible. The shells of the molluscan shell-fish when the flesh has been utilised are not to be despised, because they constitute a valuable raw material in the

manufacture of a good quality lime. Some shells like the weaving mussels (*Modiola*) when powdered can be used as poultry food or as manure for the fields. The fixation threads or byssus of its ally, *Pinna* are used in making a variety of silk. Shell-fish of the molluscan type lend themselves to cultivation in the enclosed waters of the coasts like the agricultural crops of the fields, and under competent management a constant and steady supply of shell-fish as food can be maintained in the coastal districts of the Andhra area. They are the poor man's rich food and meet the needs of nutrition of the masses for whom the costlier forms of animal food such as meat, fish and eggs are beyond their slender means. The occurrence of some forms of Holothurians (the *beche-de-mer* or "trepang" of commerce) on the Andhra coast, the smoked or dried flesh of which finds a ready sale in the Far Eastern markets should add to the means of livelihood of the Andhra fisherfolk.

Last but not least among the animal resources of the Andhra area are the cold-blooded vertebrates, the reptiles and the frogs and toads. The estuaries and deltas of the Godavari and Kistna rivers harbour a great variety of aquatic reptiles—crocodiles, turtles, lizards and snakes. The value of turtles and their eggs as food is as well-known as that of their shell as a commodity of manufacture. No one who has walked along the sea beach near Vizagapatam would have failed to note the widespread use of the carapace of turtles as baskets. The large place which the skins of reptiles in general occupy in trade and commerce makes the farming of these animals a profitable occupation. The leather produced from the skins of crocodiles, monitor

lizards and snakes is used in the manufacture of fancy articles, household goods, uppers for costly shoes, because reptile skins have a better wearing quality than mammal skins, have a great variety of pattern and texture, and can be finished off in any desired colour. Over 60 species of reptiles are used by the hide and skin trade in India, the enormous volume of which may be judged from the fact that in 1933 India exported 2·75 million reptile skins. There is no evidence that the flesh of crocodiles is valued as food in India, but it is well-known that Burmans and Karens fancy the flesh greatly. The gall-bladder of *Crocodilus porosus*, the Marsh Crocodile commands a high price in Thailand where it is believed to be a powerful antisterilitic. Farms for crocodiles, turtles, snakes and big lizards like the Monitor are known to exist in many western countries where the trade in their skins has been developed to a considerable degree.

Frogs and toads of various kinds occur all over the Andhra country in freshwater areas. The use of frogs as food in Europe particularly in France is well-known, but there are records of their being put to a similar use by certain tribes in some parts of India. The skin of frogs is said to be used in ornamental book-binding and other trades in fancy goods.

That various other animal species with which the lay public are not generally familiar, are of some food value may be judged from the fact that the poorer classes of people in other parts of the world are accustomed to a regular use of a great variety of animal food wherever they occur in great abundance at all times or

in certain favourable seasons. Whether the fishing communities on our coasts and the tribes in our forests are aware of a wide choice of animal food in their neighbourhood is a subject on which little precise information is available. Sea-anemones are sold in French markets, and are not unknown as food in Sicily and on the Adriatic coasts. The ovaries of various species of sea-urchins are eaten in all parts of the world, especially in the West Indies and the Adriatic coasts. The sea-cucumbers, the *beche-de-mer* or "trepang" of commerce, are greatly fancied as food by the Chinese and the Italians. The Samoans gather large quantities of Palolo bristleworms for use as food when they occur in plenty during their swarming periods. The fleshy stalks of barnacles of various species are regularly eaten by the Latin peoples of South America and Spain. The value of shell-fish of the molluscan type as food has already been referred to. The Adriatic fishermen include the fleshy sea-squirt or Tunicate (*Cynthia*) both in the raw and cooked forms in their menu. The insect world offers a wide range of food for various peoples of the world amongst which are the crickets, locusts, larvae and eggs of aquatic insects and midges, grubs of weevils and other beetles, secretions of scale insects, and ants, moths, Cicadas and termites. Some of these at any rate are not uncommonly used as food in the rural areas of India. The economic value of the silkworm, the lac insect, the honey-bee, the Canthárid and Buprestid beetles is too well-known to need mention here. Even the galls formed by insect activity have their uses, as for instance the Cynipid galls which are used in tanning and in the manufacture of

dyes and inks. The extracts of some insects such as bed bugs, lady-bird beetles, cockroaches, ants and bees have been admitted to European and American Pharmacopeia.

In Vizagapatam, the rain tree, *Pithecolobium saman*, is used as a lac-host, but the lac produced is reported to be of poor quality. The Eri Silk Worm (*Attacus ricini*) of Assam and Bengal has been introduced all over India in a domesticated condition. but there is no information that the industry has taken root in the Andhra area. A warm damp climate such as is prevalent in the Agency tracts of the Andhra region would prove to be suitable for the cultivation of this moth. In the jungle tracts of the maritime districts of the Andhra area, the Tasār silk worm (*Antheria paphia*) occurs either wild or in a semi-domesticated condition on Sal (*Shorea robusta*), *Zizyphus Jujuba*, *Terminalia arjuna* and *T. tomentosa*, but the silk produced is not of much commercial value.

The forests of Cuddapah, of Sriharikota island in Nellore district, and of the Agency tracts are known to be the home of honey and wax in the Andhra area, but the yield and quality of the bee products in these districts are said to be inferior to those of other centres in India. The introduction of the Italian or European bee (*Apis mellifica*) and the improvement of the Indian bee (*Apis indica*) by breeding may improve the quality and quantity of honey and wax production in this region. In modern times bees wax has a competitor in the wax produced by plant lice and scale insects, and in China the latter are an important commercial commodity. The role of the termites in breaking up soil like the earthworms and in destroying wood and wood-work

is well-known. The material of the termite nests is used as earth for brick and road-making in some parts of Africa, but no use seems to be made of the large termite mounds which are found in India.

The mention of aboriginal tribes in connection with the utilisation of the animal wealth of the Andhra area may seem out of place if not absurd, but the role that these tribes play in the collection and transport of forest produce from the unhealthy and inaccessible interior of forests to the outskirts of the plains is often ignored. The hill tribes of the Agency tracts, the Chenchus of the Nallamalais, and the Yenadis of the Sriharikota island form an important link in the life line of commerce in the Andhra country, but for whom, immune as they are to the dangerous types of malaria and other diseases prevalent in the forests, the exploitation of forest products would be impossible.

This brief and admittedly imperfect account of the fauna of the Andhra region reveals that the economic resources in respect of its animal wealth are unexploited though abundant, and that for a fuller exploitation of this wealth a wider and a more thorough knowledge of all the elements of the fauna in various types of habitats is indispensable. The accumulation and dissemination of fundamental knowledge are said to be the primary responsibilities of Universities, and the Andhra University which is about to inaugurate the study of natural sciences under its auspices has a unique opportunity to make the fauna of the Andhra area better known to the rest of India and to the world. It is often difficult to resist the temptation of following the beaten

track in respect of curricula and studies, and once the decision to conform to type is taken the spontaneous growth of fresh ideas is arrested. The excellent situation of the Andhra University at Waltair and some of its constituent colleges at Vizianagaram, Cocanada, and Masulipatam on or near the sea-beach and the connected extensive backwaters and estuaries, the situation of the Rajahmundry College at the head of the Godavari delta, and of the Pārlākimedi College with its hinterland of hills and forests offer unique opportunities for their staff and students not only to study animal life first-hand as it should be done, but also to lay the foundations for a comprehensive survey of the fauna of the maritime districts of the Andhra area. In fact, nothing would be more appropriate to the inauguration of biological sciences as subjects for study in the Andhra University than the establishment of a small marine biological station at some suitable spot near the entrance to the Vizagapatam Harbour. It would be a good rule to insist that no University teacher of a constituent college who has not spent a full term, if not a whole year, at this station working under competent Biology professors will be allowed to teach Biology. Students who have undergone their degree course in such an institution will be far better equipped to deal with fishery and kindred problems of Biology than those who have spent two years or more in a Laboratory however well-equipped with microscopes, microtomes, museum specimens and text-books of Biology. In a few years there will be a sufficient number of competent young Biologists whose title to exploit the natural resources in animal wealth will be unquestioned. The educative

propaganda which these University men with a thoroughly practical training can carry on among the masses who subsist on the aquatic resources of the Andhra area will be far more effective in improving their economic condition than haphazard measures of amelioration which bear no relation to the lives of the people. The Andhra University can, by adopting a bold and forward line of action, inaugurate a new policy of biological education which will gradually infiltrate to all strata of society and prepare the ground for the appreciation of the necessity for a full and profitable exploitation of the faunal resources of the Andhra country.

A bibliography of the fauna of the Andhra area is not included here as the references are scattered in the volumes of many periodicals and journals. But it will be useful to mention that the main body of information has been obtained from the *Journal of the Bombay Natural History Society*, the *Records* and *Memoirs of the Indian Museum*, the '*Investigator*,' Reports, Alcock's *A Naturalist in the Indian Seas* (John Murray, London, 1902), the *Fauna of British India*, the *Imperial Gazetteers of India*, and the publications of the Madras Agricultural and Fisheries Departments and of the Imperial Council of Agricultural Research in India.

CHAPTER II.

FLORA AND THE PLANT RESOURCES OF THE ANDHRA AREA

BY

MR. J. VENKATESWARLU, M. Sc.
(Andhra University, Waltair.)

FLORA

The flora of the Andhra area falls into the Deccan province as described by Sir Joseph Dalton Hooker* in 1904 in his 'Sketch of the Flora of British India.' The Andhra area may be roughly divided into two main floristic regions: (1) The Sal region formed by the area north of the Godavari river and (2) The Deccan proper constituted by the Lower Godavari, Kistna, Guntur, Kurnool, Bellary, Anantapur, Cuddapah, Chittoor and Nellore districts. A third region, however, constituted by the area between the rivers Godavari and Kistna is sometimes recognised and it may be looked upon as a transitory zone between the two above described main floristic regions

Each of the above regions may further be distinguished into three zones (i) The coast, (ii) The hills and (iii) The plains. The three zones show assemblages

* Hooker divides the whole of India (including Burma, Ceylon and Malaya) into 9 botanical provinces. Besides Hooker, others like Clarke, Champion, Chatterji, Calder have paid attention to the division of India into various botanical provinces All of them are agreed about the formation of Deccan as one of them.

of plants differing from each other. The coastal flora consists of a few distinct habitat types. The estuarine belts of mangrove forests in the deltas of the main rivers comprising of such species as *Avicennia officinalis*, *A. alba*, *A. marina*, *Sonneratia apetala*, *Rhizophora mucronata*, *Ceriops Roxburghiana*, *Bruguiera conjugata*, *Lumnitzera racemosa* along with some halophytic chenopods and other species such as *Suaeda maritima*, *S. nudiflora*, *Salicornia brachiata*, *Arthrocnemum fruticosum*, *Sesuvium Portulacastrum* and a few grasses represent one type. Another type is represented by a number of sand binding species such as *Spinifex littoreus*, *Ipomaea Pes-caprae*, *Launaea pinnatifida* etc., which inhabit the dry sandy foreshore along with clumps of *Pandanus* groves. A third type is formed by the various marine algae such as *Ulva* sp., *Enteromorpha* sp., *Caulerpa* spp., *Padina* sp., *Sargassum* sp. etc., which grow attached to the rocks that are situated between the tide marks or at greater depths along the coast. The hills are constituted by the Eastern Ghats, a disjointed line of small confused ranges, running parallel to the coast through the various districts from north to south. They are about 2,000 ft. in elevation on average and the highest peaks in the area are below 5,000 ft. In the Sal region, they run close to the coast of the Bay of Bengal sometimes separated only by a 20 miles wide strip of land thus coming within direct influence of the sea. As they travel southwards into the Deccan proper they recede farther inland and leave a stretch of low country 100—150 miles wide between the easternmost spurs and the sea. In the Kurnool district the range widens out to form the Nallamalai hills (3,000 ft.) and the

Yellamalai hills (600 ft.). Farther south in the Cuddapah district they are known as the Pālakonda and Sèshachalam hills and in the Chittoor district as the Nagari hills (2,000 ft.). The forest growth of these hill tracts is of the dry deciduous type. However, the hill slopes with an eastern aspect, particularly in the northern districts, are clothed with comparatively ever green species. The Sal region in the north derives its name from the rather abundant presence of the Sal tree, *Shorea robusta*, which finds its natural southern limit near the Godavari. The northernmost part of the Sal region is floristically linked with the temperate and sub-tropical floras of the Eastern Himalayas, Burma and Assam. Species such as *Thalictrum javanicum* (Mahendragiri), *Pygeum acuminatum* (Rampa hills; 2,000 ft.), *Ardisia depressa* (Hills of Vizagapatam district; 4,000—5,000 ft.), *Beilschmiedia Roxburghiana* (Vizag and Godavari districts; 1,500 – 4,000 ft.), *Cyclostemon assamicus* (Palakonda hills, Vizag Dt.,) occur in this region and all these show an affinity with the floras of the humid districts of Assam and Burma. Besides these a number of other species like *Xylia xylocarpa* (Irulwood), *Chloroxylon Swietenia* (Satin wood), *Terminalia chebula* (Myrobalans), *Terminalia tomentosa* (Laurel), *Pterocarpus Marsupium*, *Anogeissus latifolia* and *A. acuminata* grow on the banks of streams while, the outer slopes are covered with Bamboo. In the low hills of this region are found Nuxvomica and Ebony. The flora of the area between the Godavari and Kistna rivers presents no great difference from the above except that the more northern species gradually disappear along with the Sal tree. The forests near the Godavari contain Teak, (*Tectona*

grandis, which also occurs at intervals in the whole of the area of the Deccan proper. In the latter the forest growth is mainly of the dry deciduous type and contains a large number of species common in the northern districts. In these forests grow a good number of valuable wood trees like Red Sanders (*Pterocarpus santalinus*), Sandal wood (*Santalum album*), Satin wood (*Chloroxylon Swietenia*), Anjan wood (*Hardwickia binata*), Toon wood (*Cedrela Toona*), Laurel (*Terminalia tomentosa*), Bijasal (*Pterocarpus Marsupium*). Bamboo also occurs here in abundance. In the minor scrub jungles, clothing the lower hills, occur such plants as *Zizyphus Jujuba*, *Carissa Carandas*, *Acacia Sundra* and other thorny shrubs. In general the vegetation is more sparse than in the Sal region and characteristic of dry regions with low rainfall. The flora of the great cultivated plains of the northern districts presents a great mass of diverse species comprising representatives of the Chief orders of the Indian plants, while the flora of the low country between the western districts and the sea is comprised of such species as *Capparis zeylanica*, *Prosopis spicigera*, *Cassia auriculata* and *Acacia* species.

The flora of the Andhra area comprises of about 2,106 species, and Leguminosae (232 species), Gramineae (223 species), Cyperaceae (86 species) and Rubiaceae (74 species) form the first four dominant families. The cryptogamic flora of the area has received even a more scanty attention than the flowering plants. The writer's own collections from the northern districts indicate that further collection work in this little explored northern area would add very largely to the number of genera and species recorded in the area.

THE PLANT RESOURCES

The plant resources of the Andhra area fall into two main categories: (1) Forest resources and (2) Agricultural resources.

1. Forest Resources

The Forest products may again be broadly classified under the following heads: (i) Timbers and woods used for various purposes, (ii) Sandal wood, (iii) Bamboo and other materials suitable for making paper pulp, (iv) Fuel wood and Charcoal and (v) Minor Forest products.

(i) *Timbers* and *woods*: In the Forests of the Andhra area are found about 200 species of trees capable of attaining one foot or more in diameter out of a total of about 470 species of such trees occurring in the whole of the Madras presidency. The timber output of our forests comes to about $\frac{1}{4}$th of the total output of the Madras presidency (3,764,000c. ft. in 1937-'38). Lushington has classified the timbers of our presidency into 5 value classes based on size, durability (resistance to insects, fungi and decay), power of utilization and abundance. About 13 woods belonging to I class occur in our presidency and 8 out of them occur in the forests of the Andhra area. They include such valuable timbers as Kusum (Tel. Puska, *Schleichera trijuga*) growing in most districts of the area, Toon wood (Tel. Nandichettu, *Cedrela Toona*) in the agency tracts of the Sal region in the north and in the hills of Kurnool in the Deccan region, Rose wood (Tel. Jitègi, *Dalbergia latifolia*) in the Godavari forests and in all forests of the Deccan region, Irul wood (Tel. Konda Thangèdu, ***Xylia***

xylocarpa) in the forests of the Sal region, Anjan wood (Tel. Yèpichèttu, *Hardwickia binata*) in the Ceded districts forming gregarious forests as also in the Godavari, Kistna and Guntur districts, Teak (Tel. Tèku, *Tectona grandis*) in the forests of the Deccan region. From the II class of woods, out of a total of about 70 in the province, about 37 woods occur in the forests of the Andhra area. These include satin wood (Tel. Billu, *Chloroxylon Swietenia*) occurring in the forests of the Northern Circars and the dry deciduous forests of the Deccan region, Sal (Tel. Sala vrukshamu, *Shorea robusta*) in the Sal region, Red Sanders (Tel. Raktha Chandanamu, *Pterocarpus santalinus*) in the forests of Kurnool, Cuddapah and Chittoor, Ougein Rose wood (Tel. Tella Moduku, *Ougeinia dalbergioides*) in the forests of Ganjam, Vizag and Godavari districts, Bijasal (Tel. Yègisa, *Pterocarpus Marsupium*) in the deciduous forests of all districts, Laurel (Tel. Nalla maddi, *Terminalia tomentosa*) in the deciduous forests of Vizag, Godavari and Bellary districts, Ebony (Tel. Nalla uti, *Diospyros Ebenum*) in the forests of the Deccan region and Axle wood (Tel. Chirimānu, *Anogeissus latifolia*) in dry tracts of most districts of Northern circars and Deccan. About 85 woods of the III class out of a total of about 300 woods in the whole of the presidency occur in the Andhra area and are represented by such woods as shaitan wood (Tel. Edakula ponna, *Alstonia scholaris*) growing in deciduous forests of the Deccan region, Samul (Tel. Buruga, *Bombax malabaricum*) in all forest districts, Mango (*Mangifera indica*) Jhingan (Tel. Gumpèna, *Odina Wodier*) etc., in most districts. About 55 woods of the IV class occur in the area out of a total of about 150 in

the presidency while only about half a dozen of the V class occur in the area.

The various woods and Timbers available in the area are too many to be detailed here and they are put to various uses such as in construction and general carpentry, Boat and ship building, Railway sleepers, carving, Pencil woods, Turnery and Toy making, making match sticks, Box wood and preparing packing cases and plywood etc.

(ii) *Sandal wood:* Next in value to our Timber and wood trees growing in the area comes Sandal wood (*Santalum album*) which grows abundantly in the forests of the Deccan proper and yields considerable revenue.

(iii) *Materials suitable for making paper-pulp:* Bamboo occurs in very great abundance in the dry forests of the area and forms a good material for making paper pulp. Besides this a number of other plants yielding materials suitable for making paper pulp are also found in the flora of the Andhra area. Soft woods of *Boswellia serrata*, *Cochlospermum gossypium* and the fibrous stems of *Urena lobata* may easily form suitable materials for preparing inferior type of paper and paper boards. *Lantana*, a dreadful pest in the area, may be used for preparing a fairly good quality of paper as was recently demonstrated at Wardha. Botha grass (*Cymbopogon coloratus*) and spear grass (*Heteropogon contortus*) occur in large quantities in the districts of Cuddapah and Kurnool and tests on these have shown that these can be used for preparation of good paper. Marul fibre (*Sanseviera Roxburghiana*) is also available in the area and may be similarly employed for making good paper-pulp.

(iv) *Fuel wood and Charcoal* :—Wood for fuel is mainly formed by the Casuarina, *Casuarina equisetifolia*, an exotic plant thriving very well in the coastal districts where there are good plantations of this tree. In the delta region of the Godavari district, the wood of *Avicennia officinalis*, the white mangrove, is extensively used as fuel wood. *Trema orientalis*, the Charcoal tree, is excellent in its yield of good charcoal and this tree grows very rapidly and along with the availability, in the area, of other trees yielding fuel wood, the preparation of charcoal holds out a promising future especially with the increased use of charcoal gas as motive power for vehicles. Other plants of the area that form good fuel wood are *Zizyphus Jujuba*, *Prosopis spicigera* (Tel. Jammi), *Acacia* [illegible] (Tel. Tumma), *Tama indus indica* (Tel. Chinta) etc.

(v) *Minor Forest products* :—These include (a) Tannin-bearing materials, (b) Vegetable dye stuffs, (c) Crude drugs and (d) Gums besides a number of other useful materials like edible fruits, Soap nuts, platter leaves etc.

(a) *Tannin bearing materials* :—Plants yielding avaram bark (Tel. Thangèdu, *Cassia auriculata*), Rella Bark (Tel. Rella, *Cassia fistula*), Babul Bark (Tel. Thumma, *Acacia arabica*) Myrobalans (Tel. Karakkayalu. *Terminalia chebula*) occur in plenty in the Andhra area. Besides these *Caesalpinia coriaria*, Divi-Divi, an exotic plant, has established itself very well in the flora of the area. The fruits of this plant and Myrobalans are the richest of the South Indian Tannin-bearing materials. Wattle bark is much richer in tannin content than these and the infusion prepared from it keeps better, the loss

of tannin being low. This plant has been introduced in the South and may also thrive well in some localities of the Andhra area if introduced.

(b) *Vegetable dye-stuffs* : —*Bixa orellana* is cultivated to some extent in the area for its dye, Annattoe, which is formed by the outer resinous coating of its seeds. It is possible to extend this cultivation. Kamala, a bright orange dye, is formed by the glands and hairs that coat the capsules of *Mallotus phillippinensis* (Tel. Vasanta gunda chettu) which grows in all the forest districts of the Northern circars and the Deccan and is especially common in the deciduous forests and open scrub lands. Turmeric plant, *Curcuma longa*, is cultivated as a crop in the area and the once flourishing extensive cultivation of the Indigo plant is now largely killed due to the synthetic manufacture of the dye and the consequent cheap cost at which it could be got when compared with the natural product. Growing in the area there are some other plants such as *Pterocarpus santalinus* (Red Sanders), *Oldenlandia umbellata* (chay-root, Tel. Chiruvèru), *Morinda tinctoria* (Tel. Thogaru), *Lawsonia inermis* (Henna dye, Tel. Gorinta) *Nyctanthes Arbor-tristis* (Tel Parijatamu) etc., the parts of all of which yield dye-stuffs.

(c) *Crude drugs* :—*Strychnos Nux-vomica*, the seeds of which are very largely exported, grows very abundantly in the hills of the Northern Circars, Deccan and Carnatic in deciduous forests up to a height of about 4,000 ft. above sea level. *Holarrhena antidysenterica* grows in all forests districts up to 3,000 ft and yields the Kurchi bark, while *Alstonia scholaris*, the source of Dita

bark, grows in the forests of the Deccan region. The Indian Squill, *Urginea indica*, occurs all along the coast and the Indian Sarasaparilla, *Hemidesmus indicus* (Tel. Pāla Sugandhi) grows commonly in all plains districts, in open forests, waste places and hedges. Besides these a large number of medicinal and poisonous plants such, as *Adhatoda Vasica*, *Centella asiatica*, *Datura alba*, *Anamirta cocculus*, *Aloe vera* etc., grow in the area.

(d) Gums :—Acacia arabica, the Babul tree, is very common in the flora of the area and yields a gum which may easily form a substitute for Gum Arabic which is derived principally from *Acacia Senegal*. Ghatti gum, which is used for pharmaceutical purposes, is yielded by *Anogeissus latifolia*, a prominent and abundantly occurring plant of our forests.

Besides the above enumerated plants forming the main forest resources of the Andhra area, there occur in the flora numerous plants which may serve as host plants for Lac insect such as *Schleichera trijuga*, *Cajanus indicus*, *Butea frondosa*, *Shorea robusta*, *Zizyphus Jujuba*, *Acacia arabica* as also host plants for silk worm such as *Morus* sp. (Mulberry), *Bassia latifolia* (Mahua, Tel. Vippa), *Anogeissus latifolia* (Dhaura), *Bauhinia variegata* (Tel. Deva Kanchanamu), *Bombax malabaricum* (Tel. Buruga), *Ricinus communis* (Castor), *Careya arborea*, *Carissa Carandas*, *Chloroxylon Swietenia*, *Dodonaea viscosa*, *Syzigium Jambolanum* (Tel. Nèrèdu), *Ficus Benjamina*, *F. religiosa*, *F. retusa*, *Lagerstroemia indica*, *L. parviflora*, *Tectona grandis*, *Terminalia Arjuna*, *T. bellerica*, *T. catappa*, *T. tomentosa* and *Zizyphus Jujuba*.

2. Agricultural Resources

The Andhra area is predominantly agricultural and the crops raised in the area account for a very considerable part of the revenues of the presidency. The principal crops may be grouped as follows: (i) Food crops, (ii) Sugar-cane, (iii) Spices, condiments and narcotics, (iv) Fibre crops, (v) Oil-seed crops and (vi) Plantation crops and Fruit plants.

(i) *Food crops.*—The most important of these is Rice and several varieties of it are under cultivation in the coastal districts. The predominant method of cultivation is of transplanting the seedlings into previously prepared water puddles and to a slight extent the method of broadcasting is also followed in some parts of the area. Next in importance to this are the various Millets namely (*a*) Cholam (Tel. Jonna, *Andropogon Sorghum*), (*b*) Cumbu (Tel. Sajjalu, *Pennisetum typhoides*), (*c*) Ragi (Tel. Chodi, *Eleusine coracana*), (*d*) Tenai (Tel. Korralu, *Setaria italica*) and (*e*) Varagu (*Paspalum scrobiculatum*). Maize (Tel. Mokka Jonna, *Zea Mays*) is also cultivated to a small extent. Among the pulses cultivated in the area are the green gram (Tel. Pèsalu, *Phaseolus Mungo*), the Black gram (Tel. Minugulu, *P. Mungo var. radiatus*), the Red gram (Tel. Kandulu, *Cajanus indicus*), and the Bengal gram (Tel. Sēnagalu *Cicer arietinum*). Here may be mentioned the chief starch tuber bearing crops of the area namely the sweet Potato (*Ipomaea Batatas*) and the Tapioca (*Manihot utilissima*) which form edible starch tubers and are mainly cultivated in the coastal districts. *Maranta arundinacea*, the Arrowroot, is commonly cultivated in

the agency tracts of the Vizag district and the starch from its tubers (Pāla gunda) is used in the northern districts in the preparation of some sweet dishes. All these are suitable sources for the manufacture of starch. It may also be mentioned that various vegetables grow in the area and they are too numerous to be detailed here.

(ii) *Sugar-cane*:—This crop is mainly cultivated in the Vizagapatam district and to a slight extent in the East Godavari district. It forms a link between the food crops and the commercial crops.

(iii) *Spices, condiments and narcotics*:—Chillies, Coriander, Ginger and Onions are the chief spices and condiments cultivated in the area. Chillies (*Capsicum annuum*) is chiefly grown in Vizag, Godavari, Kistna, Guntur, Kurnool and Nellore districts, Coriander (*Coriandrum sativum*) mainly in the Guntur district and Onions (*Allium Cepa*) mainly in the districts of Godavari, Anantapur and Cuddapah.

Tobacco cultivation has been extremely successful in the Guntur district. Extensive areas in this district are suited for cultivating very good varieties of cigarette Tobacco. Tobacco cultivation has now been extended to Kistna and the Godavari districts also. Tobacco of lesser quality is also grown in the Vizagapatam district and to some extent in Chittoor district. Guntur district alone produces Tobacco worth about Rs. 4½ crores.

(iv) *Fibre crops*:—These are represented by cotton (*Gossypium* sp.) grown in Guntur, Kurnool, Bellary,

Anantapur, Cuddapah and Nellore districts; Bombay or Deccan Hemp or Bhimlipatam jute (*Hibiscus cannabinus*) and Rozelle hemp (*H. Sabdariffa*) grown mainly in Guntur (about 21,000 acreage), Kistna (5,000 acreage), and Vizagapatam (11,000 acreage) districts. Besides these, Sun hemp, (*Crotalaria juncea*) which is mainly grown as a green manure, is also used for extraction of its fibre. Various palms, that grow in the flora or cultivated for other purposes like Coconut (*Cocos nucifera*), Toddy palm (*Borassus flabellifer*), *Caryota urens* (Tel Jeeluga), Pandanus sp. (Tel. Mogali) etc, also yield fibre from their stems, leaf-stalks and fruits, and these are generally used in preparing ropes, brushes and similar articles.

(v) *Oil Seed crops*:—The chief oil seed crop of the area is groundnut (*Arachis hypogaea*) which is mainly cultivated in Vizag, Kistna, Guntur, Kurnool, Bellary and Anantapur districts. The oil is chiefly used for edible purposes and may be employed to replace olive oil as a culinary oil and also in the manufacture of margarine Gingelly (*Sesamum indicum*) is grown in Vizagapatam and Godavari districts and castor (*Ricinus communis*) in Guntur, Kurnool and Anantapur districts. Niger seed (Tel. Valisèlu, *Guizotia abyssinica*) is cultivated in the hilly tracts of the northern area and Coconut in the East Godavari and West Godavari districts. Mustard (*Brassica* sp.) is also cultivated in the area to some extent. There are other oil seed bearing plants like *Pongamia glabra* (Tel. Gānuga or Kāgu), *Azadirachta indica* (Tel. Vèpa), *Centratherum anthelminticum* etc., growing in the area.

(vi) *Plantation crops and Fruit trees*:—Coffee is the only important plantation crop of the Andhra area and is confined to the hills of the Agency tracts of Vizagapatam district. The Cashew-nut plant (*Anacardium occidentale*) thrives very well on the sea-shore and plantations raised there should yield very good results. In the plains the Papaya tree (*Carica Papaya*) thrives well and if planted would be a good source for extracting papaine from its latex. The writer has come across a few cultivated specimens of the Rubber plant, *Hevea braziliensis*, thriving well in the hills of northern districts and experimental measures to plant these on the hills may become successful if undertaken.

Fruit trees of the area are generally cultivated in the form of small groves. Fruits of citrus variety—Kamala oranges (Agency tracts of Vizag district), Lemons (East and West Godavari districts), Narinja (Guntur Dt.), Batavia and Shaddock are available in the area. Pineapple (*Ananas sativus*) thrives in cultivation on the hill slopes of Vizag district and Plantains are raised in the plains. Mangoes and Sapodilla fruits (*Achras Sapota*) are also available in the area. There is much scope, however, in the area for the extension and improvement of the cultivation of the Fruit plants. Besides these a number of other fruit plants such as Pomegranate (*Punica granatum*), Gauva (*Psidium Guajava*), Custard-apple (*Anona squamosa*), Jack (*Artocarpus integrifolia*), Country-date (*Phoenix sylvestris*, and *P. farinifera*), Jambolan (*Syzigium Jambolanum*), Ber (*Zizyphus Jujuba*) etc., grow in the area either in cultivated or wild state.

In the accompanying table is given some data regarding the acreage and value in rupees of some of the agricultural products :—

Name.	*Acreage.*	*Value in Rupees.*
Paddy ...	37,26,293	18,33,12,000
Cholam or Jonna ...	5,99,490	3,75,77,000
Cumbu or Sajjalu ...	2,70,760	1,71,08,000
Ragi or Chodi ...	3,13,840	1,70,05,000
Tenai or Korralu ...	1,58,400	90,30,000
Maize or Mokka Jonna ...	15,590	9,80,000
Green gram ...	15,036	27,26,000
Black gram ...	11,200	12,20,000
Red gram ...	19,128	18,54,000
Sugar-cane ...	1,64,400	1,49,35,000
Tobacco (only of Vizag and Guntur dts.).	1,80,378	5,21,52,000
Bombay Hemp ...	——	36,78,000
Cotton ...	17,837	89,25,000
Groundnut ...	11,82,300	9,46,07,000
Gingelly	16,650	27,77,000
Castor ...	11,070	14,78,000
Chillies ...	71,896	2,95,10,000
Coriander ...	18,288	5,49,000
Onions ..	15,380	30,76,000
Mangoes ...	——	2,48,42,000
Plantains ...	——	52,45,000

An effort has been made in the foregoing pages to present an outline of the flora and the plant resources of the Andhra area. The Forest Department of the Government of Madras has been doing much towards the

improvement of the forests by afforestation, regeneration, reservation and by employing improved methods of Silviculture etc. The Agricultural Department, Government of Madras, has been doing good work through the various stations in the area dealing with problems regarding the cultivation of crop plants, breeding improved strains, controlling diseases and tackling problems connected with manures and fertilizers. If the cultivator is educated about the adoption of scientific methods of agriculture the already rich agricultural resources of the area would become richer.

The attention paid to the survey of the flora of the area is very scanty and meagre. A sustained and systematic collection of plants would no doubt help in having a full knowledge of the flora, especially in the agency tracts of the northern districts and would enlarge the number of species and genera recorded from the area. The study of the various plants in the area, specially the Economic plants in relation to their environment, is another interesting field which has not been touched at all.

REFERENCES.

1. Administration Reports of the Forest Department of the Madras Province, 1938 and 1939.
2. Administration Report of the Dept. of Agriculture of the Madras Presidency 1938–39.
3. An outline of the Field Sciences of India, Indian Science Congress Association, 1938.
4. Commercial Products of India by Watt, 1908.

5. District Gazetteers of the Vizagapatam, Godavari and other Districts.

6. India and Madras Presidency at a Glance, the Madras Industries Association, Madras.

7. Madras Timbers by A. W. Lushington.

8. A note on the Industrial uses of Forests in Madras Presy. and the possibilities of their development, 1939 by V. S. Kuppuswamy.

9. A Sketch of the Flora of British India, by Sir J. D. Hooker, Imperial Gazetteer, Vol. I, 1907.

10. Flora Andhrica by W. Elliot, 1859.

11. Flora of the Madras Presidency Vols. I—III, 1935 by J. S. Gamble and C. E. C. Fischer.

12. Flora and Fauna of South India, 1928 by R. V. Seshaiya.

13. Flora of British India by Hooker Vols. I—VII.

CHAPTER III.

MINERAL RESOURCES OF ANDHRA DESA

BY

DR. C. MAHADEVAN, M.A., D.Sc, F.A.Sc.

(*Hyderabad Geological Survey, Hyderabad.*)

We are on the threshold of an industrial renaissance and the talk of starting new industries is on everybody's lips. The absence of an accurate knowledge of the potentialities as well as the limitations of the available raw materials by the capitalist, the government and the public often leads to exaggerated claims of the possibility of creating a new heaven, or pessimistic notes deprecating any hope of looking forward to a period of economic and industrial self-sufficiency and independence. It is well to realise at this stage that most of the conflict that the world is now witnessing is the direct result of blind industrialisation without planning, avarice for exploitation, over-production, dumping, and the desire to subjugate weaker countries for raw materials and markets for the finished product. This is due, in the first instance, to the lack of co-ordination in a nation, of the capitalist, the scientist, the government, and political economist; and secondly, due to the absence of an international policy for rational development. There is no doubt that in New World Order, it would be necessary to consider industrialisation as a world problem and not merely as a national or provincial affair.

Quick communication and the progress of scientific research, resulting in the discovery of cheaper synthetic substitutes have introduced complexities into the already complicated economic system. These facts have to be thoroughly borne in mind when the question of the industrialisation of our country or part of the country is seriously taken up for consideration.

Coming now to the subject under discussion, the possibility of developing the metalliferous industries in the Andhra Desa has been ably dealt with by Dr. M. S. Krishnan. As I have pointed out in a recent publication of the Andhra University on the subject of the Mineral Resources of Andhra Desa, it is believed that this unit is very rich in certain raw materials, though due to absence of careful and detailed work we possess but very meagre information about the actual possibilities; spade work entailing hard and conscientious geological survey and prospecting will be the prime necessity. It is to be hoped that in the new Natural Scienc Department to be started in the University, geology will become a living and practical subject aiming at the training of young men who will be fit to carry out work pertaining to the practical aspects of geology.

The following minerals have been reported to occur in Andhra Desa :—

Antimony.
Asbestos.
Barytes.
Bauxites.
Building materials.
Corundum.
Garnets.
Gem stones (both precious and semi-precious such as diamonds, saphires, garnets, cordierites, agates, amethyst).

Gold.
Graphite.
Gypsum.
Kaolin.
Lithographic stone and limestones.
Manganese.
Micas.
Mineral waters.
Monazite.
Ochres.
Phosphates.
Quartz and sands.
Radio-active minerals.
Silver.
Salts.
Steatite.
Pot stone.
Zinc.

Of these, those that are known to exist in workable quantities and have been exploited either in the recent past or are being exploited at the present are :—

Asbestos.
Barytes.
Bauxite.
Building stones.
Copper.
Diamonds and semi-precious stones.
Gold.
Granite.
Iron.
Kaolin.
Manganese.
Micas.
Marbles.
Ochres.
Phosphates.
Quartz and sands.
Salts.
Zircon.

We may briefly review here the possibilities of the utilisation of these minerals that are known to occur in workable quantities, in the various industries

Copper :—Copper is one of the most useful elements in industries and arts. Its greatest use at the present time is in the manufacture of sheets for warships, cruiers, etc., conducting wires for electrical purposes;

besides, it is used with other metals such as zinc, tin, etc., for the manufacture of alloys.

Diamonds:—Diamond, when free from flaws, has a value as a precious gem, but that of poorer quality finds wide industrial application as bort, used in drilling bits for easy boring into hard rocks; diamond powder is much prized as an abrasive in the gem cutting industry.

Graphites:—Graphite has a wide industrial application. Black lead pencils are all made of graphite. It is one of the best-known lubricants, particularly for high-temperature duty. The chief use is as a refractory material for the manufacture of crucibles. It is used with pyrolusite (manganese dioxide) in dry batteries.

Manganese:—Manganese, besides being one of the most important elements in the steel industry and in the metallurgy of iron, finds extensive application in chemical industries. It is essential for the manufacture of chlorine. Oxide of manganese is used for decolourising and as a depolariser in dry batteries. It is used for glass and porcelain industries as a colouring agent. The potassium permanganate industry consumes quite a large quantity of manganese ore.

Micas:—Mica is put to several uses in industry. The greatest use is for electrical purposes. Its high insulating property combined with flexible immunity to cracking on sudden temperature variation and the ease with which it splits into thin sheets gives it a unique value in electric appliances and in the making of dynamos, transformers and condensors. The waste mica can be used for the micanite industry by compressing it with

shellac as a binder. Micanite tubes find extensive use in electrical industry.

Mica can be made into chimneys for lanterns. It also finds a large use in decorative and ornamental work. The waste scrap of mica lends itself to be fashioned into non-conducting packings such as jackets for boilers and steam pipes. On account of it being a poor conductor of heat, scrap mica, interleaved in the ceiling can be used as a screen and is claimed to perceptibly keep out heat during summer. It is also used with graphite as a lubricant for bearings working under heavy pressure. It serves as a base for soap and as inert-absorbent medium for taking up nitro-glycerine in the manufacture of dynamite. Fire bricks are made out of compressed mica and have proved to be of great utility.

Asbestos :—Asbestos, being a non-conductor of heat and a refractory, is used as packing material for steam pipes. Fire-proof bricks, cloths, ropes and various other materials are made out of these. Products of asbestos find extensive use in motor and electrical industry.

Barytes :—Barytes is used on account of its high specific gravity for the weighting of mud-fluid in rotary drilling. The better grades are used as inert-filler in paper, cloth and linoleum, and as a base in the paint industry. In combination with zinc sulphide it is used for the manufacture of a product called Lithopone which finds great industrial application in the manufacture of paints and high grade rubber goods.

Bauxite :—This is the chief ore for aluminium. The importance of aluminium in industry hardly requires

to be emphasised. Cryolite which is the other raw material required for the reduction of bauxite to aluminium is now made synthetically and electrical metallurgy has greatly simplified the process of the manufacture of aluminium from even low grade ores. Bauxite is also used in the cement industry.

Ochres:—Ochres find extensive use in paint and pigment industry.

Kaolin:—This is raw material for the maufacture of porcelain ware for domestic and electrical use. It is also used to a minor extent in the chemical industries. As is well-known antiphlogestin is only Kaolin with menthol, glycerine and a few other chemicals.

Limestones:—These are raw materials for the cement industry. As cement concrete is expanding its scope of utility, the field for cement manufacture is getting wider.

Quartz:—Vein quartz as well as river sand are used in glass industry. Salts, such as sodium carbonate etc., are required for glass industry.

Having reviewed the industrial application of the various minerals found in Andhra Desa, we shall now consider the major industries that they can foster in different zones.

ELECTRICAL GOODS (NELLORE DISTRICT).

Both copper and zinc are found in workable quantities in Nellore district and this area is admirably suited for the initiation of electrical industry, such as the

manufacture of conducting wires, transformers, dynamos etc. With the growing popularity of electricity even in rural areas, and the possibility of expecting the initiation of hydro-electric schemes in Andhra Desa in measurable time it would be well-worth to consider the possibility of starting this industry in that district. Shellac as well as rubber required for the industry are had in parts of South India and can be imported.

PAINT INDUSTRY (CEDED DISTRICTS).

The Ceded districts are admirably blessed with regard to starting of the paint industry. All the raw materials such as barytes, different coloured ochres, are found quite close together in the districts of Cuddapah, Kurnool and Bellary. Paint works in other parts of India have found it profitable importing both barytes and ochres from the Ceded districts. It is surprising that this industry has not been started in the districts themselves.

BAUXITE-ALUMINIUM (VIZAGAPATAM DISTRICT)

A thorough geological survey of the high hill ranges in Vizagapatam district may yield workable deposits of bauxite though we know at present of no known rich find The area abounds in a number of waterfalls sufficiently large to generate cheap electricity. The proximity to the harbour of Vizagapatam should give an additional advantage to this industry over localities situated far in the interior such as the Central Provinces where high grade bauxite is already known to exist.

PORCELAIN AND GLASS INDUSTRY
(GODAVERI AND VIZAGAPATAM DISTRICTS).

Good Kaolin is known to occur in the districts of Godaveri and Vizagapatam. The granites of the area are also known to possess pegmatite veins from which feldspar of the required quality can be easily obtained by hand-picking. Fire-clay is found in several parts of Godaveri district in association with the Gondwana formations. The possibility of starting ceramic and fire-brick industry in Godaveri or Vizagapatam district is well-worth investigation. As graphite is also found in the Godaveri district in workable quantities the manufacture of crucibles and other refractories is a possibility that is deserving of examination.

LUBRICANTS
(EAST GODAVERI AND NELLORE DISTRICTS).

The graphites of East Godaveri and Micas of Nellore could both be utilised in the preparation of lubricants for high pressure machinery. It would be advisable to have this industry in the Nellore district as there is already scope there for the manufacture of other electrical goods from copper and zinc and this would form a supplement to that industry.

PENCILS
(GODAVERI AND KISTNA DISTRICTS).

The graphites of Godaveri and the Kistna district could be utilised for the starting of a pencil factory.

PAPER INDUSTRY
(VIZAGAPATAM AND GODAVERI DISTRICTS).

The Vizagapatam district which abounds in bamboo forests contains deposits of kaolin which can foster the paper industry.

ASBESTOS INDUSTRY (CEDED DISTRICTS).

Asbestos finds a very wide application in industry and the Ceded districts are one of the best situated in India with regard to the availability of raw materials for the purpose. It should be very easy to prepare the several products of asbestos and also asbestos-cement in the Ceded districts.

On account of the abundance of good asbestos deposits and the ease with which these can be exploited, a properly constituted asbestos industry can easily compete with other produce from any part of India.

FERTILISERS (VIZAGAPATAM DISTRICT).

The phosphates found in Vizagapatam district can be utilised for the preparation of fertilisers. The scope for the manufacture of other types of fertilisers requires a careful investigation.

CEMENT INDUSTRY (GUNTUR, KISTNA AND CEDED DISTRICTS).

There are already two cement factories in Andhra Desa catering to the requirements of the neighbouring provinces. The Guntur, Kistna and Ceded districts have limestones of the required quality and by utilising coal from Singareni Collieries there is a scope for cement industry to thrive in the Ceded districts to meet the local requirements. As cement is finding increasing application for reinforced concrete and also for road making there would be markets enough for the produce.

DRY BATTERIES
(VIZAGAPATAM AND GODAVERI DISTRICTS).

The Vizagapatam district which possesses manganese ores in large quantities could utilise the graphites of Godaveri for the manufacture of dry batteries. Professor Bhagavantam has demonstrated that the scope in this direction is immense.

I have tried to outline very briefly the scope for the initiation of industries in several parts of the Andhra Desa, particularly with regard to the non-metallic minerals. It must however be emphasised that spade work of considerable magnitude requiring a thorough geological survey and detailed prospecting would be the first necessity. Later, the Industrial Chemist and the Capitalist, have to put their heads together and see to what extent these industries would warrant initiation to be able to withstand competition. In a country like ours which is still very backward industrially, there is a great danger of ill-conceived attempts of starting industries on inadequate data ending in failures and thereafter discouraging the initiation of industries that can really thrive and stand competition. To avoid this, it would be necessary for all those interested in the economic well-being of the province and qualified to give the necessary advice to collaborate and consider carefully the actual conditions of raw materials, markets, possible sources of competition, etc., before launching on any scheme. It would be a sound policy to nationalize the basic and key industries and encourage private enterprise to build up subsidiary industries.

METALLIFEROUS MINERALS OF ANDHRA DESA.

BY

DR. M. S. KRISHNAN, M.A., Ph.D., F.A.SC.,

(Geological Survery of India, Calcutta.)

Minerals are generally divided by geologists into two groups—the metalliferous minerals or ores and the non-metallic minerals, the distinction being that the former are used for the extraction of metals. I shall here consider the former under the headings precious and base metals and the ferrous metals.

At the outset it may be stated that the Madras Province, of which the Andhra country is a part, has yet to be examined in sufficient detail for her resources to be known with a fair degree of precision. It will be found therefore that only the probable resources can be indicated for lack of detailed information.

PRECIOUS METALS.

Gold and silver are the most common among the precious metals. Those of the platinum group have not been discovered in workable deposits in India, not to speak of the area under consideration. These latter are known generally to be associated with ultra-basic rocks which are of rather rare occurrence.

Gold-bearing ores had been worked in the Anantapur district in the first quarter of this century but the companies engaged on the work wound up after a few years. Workable gold ores apparently exist in the Dharmavaram and Gooty taluks of this district but little

is known about their distribution or richness. The schistose rocks of the Anantapur and Bellary districts and possibly of Nellore are likely to repay investigation. But prospecting for gold is a tedious and expensive business requiring geological knowledge, proper sampling and assaying.

During the past decade, the value of gold has gone up and several new enterprises of all sizes have sprung up all over the world since many propositions which were formerly considered unprofitable or marginal can now be worked at a profit. It is therefore advisable to have the likely areas properly prospected.

Silver is often closely associated with gold and more often with lead ores. There are in fact very few mining operations in the world based on silver alone. It is a valuable by-product of lead, zinc and gold ores so that the lead ores known to exist in some parts of the Andhra country take on an added importance.

BASE METALS.

Lead:—Lead ores are known to occur in the Guntur, Cuddapah and Kurnool districts. The Cumbum stage of the Cuddapah system near Karampudi in Guntur, near Jangamarajapalle and in the Lankamalai in Cuddapah shows veins of galena. A few 'samples' collected from the latter two places are said to have yielded 65 to over 70 per cent lead. At Basavapuram in Kurnool there are disseminated ores of galena which may be workable. In all these cases there are appreciable amounts of silver associated with the lead. Some attempt seems to have been made at working some of

these deposits several decades ago but no reports of these deposits exist.

Zinc :—Though zinc sulphide is a common associate of galena the only record of its occurrence in the Andhra area seems to be from the Kurnool district.

Copper :—The existence of several old workings for copper ore is known in Nellore, especially around Garimanipenta. Some attempts were made in the earlier part of the last century to work these, but apparently they were all unsucessful. About 12 years ago a company had the area prospected by drill holes and by geophysical methods. Though a small production was recorded in 1926, 1927 and 1932, the company seems to have been wound up and no details are known as to their findings. The workings known at present are all in the oxidised zone near the surface. Very little is known whether there are any primary sulphide ores and whether there are workable lodes at depth.

Copper ores are known in a few places in the Kalahasti Zamindari and in the Udayagiri taluk. Here also there are old quarries in the oxidised zone. All these deposits would seem to require detailed prospecting.

Aluminium :—Deposits of bauxite—or highly aluminous laterite—are usually associated in India with the Deccan trap, but some have been found also over garnetiferous sillimanite gneisses. The only area which appears to merit attention in this respect is the Jeypore Samasthanam where similar gneisses are known to

occur. There are typical laterite plateaux on these rocks but they have not so far been examined in detail for their content of aluminous laterite.

FERROUS METALS.

Iron :—Several districts in the Andhra area are known to have supported an indigenous iron industry on a small scale in former days but that industry is now extinct with the advent of cheap iron produced on a large scale and imported into India.

Deposits of a size capable of supporting a modern industry exist in the Bellary, Kurnool and Cuddapah districts, so far as known at present. In Bellary the deposits occur in Dharwarian schists in close association with the well-known manganese deposits of Sandur State, some of these being reported to contain ore containing over 60 per cent iron.

There are two or three deposits of hæmatite in the Cuddapah basin near Pendlimari in the Cuddapah district and near Dhone in the Kurnool district. These contain high grade iron ore in apparently large quantities and are worthy of further investigation.

Manganese :—Deposits of manganese of considerable importance occur in the hills of Sandur State in the Bellary district and near Kodur, Garividi and other places in the Vizagapatam district. These have been described by Sir L. L. Fermor in Volume XXXVII of the Memoirs of the Geological Survey of India. The former are of lateritoid character and consist mainly of psilomelane and wad ; they range from medium grade

manganese ores through ferruginous manganese ores to manganiferous iron ores. The Sandur State should still hold large reserves of these ores.

The ores of Vizagapatam are derived from metamorphosed sediments often mixed with igneous intrusives. The ores consist mainly of psilomelane and are usually phosphatic. The extent of these deposits is not fully known.

Chromite:—Chrome ore has recently been found in the Kondapalle hills near Bezwada. It occurs as usual in association with ultra-basic rocks and serpentine. Prospecting has just been started but there seem to be indications that the deposits are of some importance.

The occurrence of iron and manganese ores together in Bellary would suggest that there are prospects for the manufacture of iron in this area. The availability of chromite near Bezwada is a factor which is encouraging. An important but discouraging factor is the absence of coal within the Madras Presidency. It should however be possible to use other sources of heat and power such as electricity and charcoal. India is still an exporter of mineral raw materials to other countries and it is high time that our industrialists start manufactures of such articles as we consume but have to import at present.

A SURVEY OF THE INDIAN CERAMIC INDUSTRY WITH SPECIAL REFERENCE TO THE ANDHRA DISTRICTS

BY

DR. G. GOPALA RAO, D.Sc.,

(Reader in Chemistry, Andhra University, Waltair.)

The story of ceramics is the story of the evolution of a lump of clay into myriads of articles of great utility and beauty, articles which are indispensable in the homes, and in the Arts and Industries. Plain and decorated glazed wall tiles, floor tiles and table tops add beauty, comfort and sanitation to our buildings. No home can be said to be modern without china and porcelain table and kitchen ware such as jars, jugs, pails, baker dishes, pudding bowls, oval vegetable bowls, French saucers, butter boxes, fruit and salad dishes, amples, milk and jam pots, dining plates, tea pots, cups and saucers, and the like.

Our teas and dinners would be deprived of their splendour and elegance but for the crackling of china and porcelain. Decorated placques, statuettes, vases and flowerpots lend grace to our drawing rooms. Every modern bath is fitted with glistening tubs, wash basins and sinks of white earthenware, easy to clean and maintain in a sanitary condition. Modern drainage schemes of Municipalities and other institutions use hundreds of tons of stoneware pipes, fittings and other ceramic products. In overhead electrical transmission lines millions of high and low voltage insulators are

used. Our telephone and telegraphic systems consume porcelain insulators by the billion. In Wireless transmitters, receivers and other Radio appliances porcelain insulating devices are indispensable. In the scientific and technical laboratories scores of porcelain articles are necessaries: crucibles, dishes, casseroles, acid bottle rests, Buchner funnels, mortars, troughs and trays, porous cups and flasks, combustion tubes and boats, etc. The development of metullurgical industries on the modern gigantic scale would have been impossible but for the availability of numerous types and grades of ceramic refractory products, furnace linings for blast furnaces, the Siemens open hearth furnaces and the Bessemer convertors in the iron and steel Industry, special crucibles for melting steel, and other alloys and metals. Wherever high temperatures are encountered, as in the construction of tank furnaces and pots for the manufacture of glass, tunnel and round kilns for pottery, enamelling furnaces, and in the construction of cement rotary kilns and various types of roasters and flues, refractories are indispensable. In the heavy chemical industries, we require equipment resistant to corrosion by acids, alkalies, and salts. In the design of chemical reaction vessels stoneware has been the material that is used since the earliest times. Stoneware is a perfectly vitrified, opaque ceramic body, white or coloured. In addition to being resistant to corrosion, it has the characteristics of high mechanical strength, resistance to thermal shock, etc. The progressive stoneware manufacturer of to-day can furnish a large variety of shapes for the chemical industries such as digestion tanks, distilling plants, pumps, pipes, cooling coils, valves.

filter towers, crystallising vats, etc. It would not be an exaggeration to say that most modern chemical and armament industries would not have been possible without the development of chemical stoneware.

This brief survey of the versatile uses of ceramic products will show how intimately our civilized life is connected with ceramics. The present may truly be described as the Ceramic Age.

The raw materials required for the different branches of the ceramic industry are widely distributed in India. India's position with regard to the manufacture of refractories and salt glazed stoneware is quite satisfactory, though there is considerable scope for expansion of these trades by stimulating internal consumption and building up an export trade. According to competent authorities, Indian made refractory goods have proved equal in strength and durability to the best obtainable in any other country. Fire clays, bauxite, silica, kyanite, sillimanite, magnesite, chromite, zirconia and graphite are the materials for the various grades of refractories. Excellent fireclays have been found in the Ranigunj coal fields, the Kolar gold fields and the area round about Jubbulpore, besides numerous other places. At present there are about ten factories engaged in the refractories trade. Bauxite occurs at Lohardaga in the Palamau district of Bihar and Orissa and Katni in the Central Provinces, besides other places. Bauxite also occurs in Jammu, Kashmir state, in the districts of Khaira, Kolhapur and Belgaum in the Bombay Presidency. Magnesite of a very superior quality occurs extensively in the chalk hills of the Salem district,

Madras Presidency. Much of this mineral is exported. Magnesite also occurs at Dod Kanya and Dod Katur of the Mysore State. Much of the Mysore magnesite is used up in India itself for the manufacture of magnesia bricks required for the steel furnaces. Other occurrences of magnesite which need be mentioned are in Baluchistan, and Manipur. For the making of silica refractories silica is obtained from the Rajgir hills in the Gaya district and also from the Kharakpur hills in the Monghyr district. The two factories engaged in the silica refractories' trade are the Kumardhubi Silica Works, situated in the Manbhum district of Bihar, and the Lal Koti Silica Works of Burdwan, Bengal. Kyanite and sillimanite form the raw materials for super refractories which are of considerable service for glass furnaces, etc. Kyanite occurs in large quantities in the districts of Singhbhum, Manbhum and in the adjacent Feudatory States. It also occurs in Ajmer-Merwara, Rajputana, in Mysore and in the Nellore district. Over 96 per cent of kyanite produced in India is mined at Lapsa Hill, Singhbhum district by the Indian Copper Corporation. Sillimanite occurs in association with corundum in the Khasi Hills of Upper Assam, and at Pipra in the Rewah State, Central India. With the exception of small quantities which are used in India in the manufacture of refractories, much of the mined minerals are exported to European countries and to the United States of America. The export of these valuable super-refractories out of India is to be very much regretted. W. H. Bates (Trans. Mining and Geological Institute of India 1933, 28, 158) writes: "The possession of such valuable refractories would be of great value to

Indian Industries in the future and it is regrettable that Government permits the deposits to be worked to the detriment of those industries which would be helped by the aid of a cheap super-refractory in competition with similar foreign industries". It will be of interest to note in this connexion that attempts to produce synthetic products are being made in countries which are not blessed with natural deposits of these minerals.

Chromite bricks are made from the ores of Chaibassa, Singhbhum district by the Tata Iron and Steel Co., Ltd., and by Messrs. Burn and Co., Ltd., in their Raniganj works. Chrome bricks are difficult to make, but are very valuable neutral refractories for steel furnaces, where corrosion to basic slags is necessary. Chromite also occurs at Hindubagh and Khanozai in Baluchistan and in the Mysore State in the districts of Shimoga, Hassan and Mysore. The Baluchistan ore is very pure, often containing 60 per cent chromic oxide. The deposits in Baluchistan and Mysore are worked for the purpose of export. It may not be out of place to mention here that this valuable mineral is of rare occurrence in the world. The chief metallurgical uses for chromium are :—(1) in alloy steels such as those used for armour plates, projectiles, automobiles, aeroplanes, railway rolling stock, internal combustion engine parts, magnets, (2) stainless steels, (3) steels for cutting tools and (4) nickel-chrome resistance wire and strip for electric heaters. It is highly deplorable that this strategic mineral is allowed to be exported out of the country.

Zircon, the orthosilicate of zirconium is obtained in the treatment of the beach sands of Travancore coast

by the Travancore Minerals Co., Ltd., at Manavala Kurichi. The sands are also the source of monazite, ilmenite and rutile and contain about six per cent of zircon which is recovered by gravity concentrators and magnetic separators. The principal use of zircon is as a high grade refractory. Articles made from this material are basic in character, have a low coefficient of expansion and low heat conductivity. It is used in the manufacture of crucibles and other articles which are intended to withstand sudden changes of temperature and chemical corrosion from molten slags and gases.

Graphite is used in admixture with fireclay for the making of graphite crucibles largely in demand in the metal casting industries. It is the principal mineral product of Ceylon, but small deposits are also reported to occur in the Travancore State, in the Tinnevelly, Godavari, Kistna and Vizagapatam districts of the Madras Presidency, in the Kalahandi State of Orissa, Bhagalpur district of Bihar Province, etc. It is unfortunate that India is not meeting her demands for graphite crucibles.

Besides the trade in refractories, India is also self sufficient in another branch of the ceramic industry, the salt glazed stoneware trade. Clays of a low fusibility are employed in the manufacture of articles which require a vitrified or partially vitrified body, such as drain pipes and fittings, non-porous roofing tiles, sanitary ware, etc. The principal factories concerned in the trade are the Ranigunj Potteries, Ltd., the Jubbulpore Potteries Ltd., the Perfect Potteries Ltd., of Jubbulpore, and the Mysore Stoneware Co., Ltd., of Chickbanavar,

Mysore State. Indian salt glazed ware is made to British standard specification and its widespread use in India, Burma, Ceylon and Malaya bears sufficient testimony to its quality. The industry is concentrated in a few centres and this has a great drawback in a sub-continent like India, where long distances and heavy railway freights add to the cost of the finished product and hinder its widespread use. But the inauguration of improved drainage schemes by Municipalities and other institutions is bound to create an increasing demand for stoneware pipes and fittings. A case is thus made out for the creation of more centrally situated factories.

From the foregoing it will be seen that India's position in regard to the manufacture of refractories and salt glazed stoneware is quite encouraging. But the position with respect to the manufacture of fine ceramics is far from satisfactory. In the year 1932–33 the total imports into India of glazed earthenware and porcelain amount to Rs. 49,56,037. This figure is showing a steady increase year after year on account of the rapid rise in the standard of life of the population. On account of the great increase in the electrical power transmission lines, industrial and scientific laboratories, hospitals, telephone and telegraphic communications, and in the general standards of life, there is an ever increasing demand for porcelain electrical insulators, laboratory porcelain ware, sanitary ware, and domestic crockery. It is essential that this increasing demand should be met by Indian manufacturers. At present the factories engaged in this business in India are :— (1) The Bengal Potteries Ltd., Calcutta, (2) The

Hindusthan Potteries, Calcutta, (3) The Art Potteries, Calcutta, (4) The Raniganj Potteries, (5) The Gwalior Potteries with works at Gwalior and Delhi, (6) The Government Porcelain Factory, Bangalore and (7) The Travancore Potteries, Kundara. These factories only manufacture special types of goods and their output is scanty and does not meet even the fringe of the demand, as shown by the heavy imports.

The raw materials required for the "Fine Ceramics" industry are :—(1) china clay, (2) ball clay, (3) felspar, (4) quartz, (5) steatite and other materials of minor importance These materials occur in abundance at various localities in India. But a few of these deposits only are worked. The Calcutta Potteries obtain their supplies from Mangalhat in the Rajmahal Hills, Bihar. In the northern Singhbhum district several deposits are worked. The Maharajah of Kasimbazar has a China clay refinery at Hat Gamaria, near Chaibassa. Seth Mangillal makes and sells white china clay for the paper and textile industry from Chaibassa. The deposits at Kasumpur near Delhi supply the requirements of Gwalior Potteries, Ltd. China clays are also found in abundance in the Bilaspur district of the Central Provinces. The Government Porcelain Factory, Bangalore gets its supplies of china clay from the deposits at Arjunbettahalli, near Golhalli, Bangalore district and from Kokkod in the Koppa Taluk of Kadur. The Travancore Potteries of the Travancore State Government makes use of china clay mined and refined at Kundara, Travancore State. Though china clay of different grades can be won and supplied from

Indian deposits, yet large quantities of the material are still imported from the United Kingdom. The average annual imports for the five years ending 1927–28 were 23,216 tons. Much of the imported China clay is used up for industries other than ceramics, in the paper and textile industries as a filling and finishing material, in the cosmetic industry as an ingredient of face powders, tooth powders and pastes, in the Pharmaceutical industry, and in other trades. Potash felspar, $K_2O.\ Al_2O_3.\ 6.\ SiO_2$ is used in the ceramic industry in the compounding of both the body and glaze. It is also an important constituent of enamels. The Gwalior and Delhi Potteries use the felspar from the Taragarh and Babugarh hills of Rajputana. In the Mica fields of Bihar, there is an abundance of good felspar. The Government Porcelain Factory, Mysore State, draws its supplies of felspar from a pegmatite vein at Shettihalli, near Chick-banavar, and white quartz is secured from Peenya near Yeswantpur. The mica mines of Nellore provide abundant supplies of excellent felspar and quartz. Ball clays, steatite and other raw materials are also available in various localities in India. And yet India has not organised a porcelain industry, worth the mention.

The successes achieved by India in the refractories and salt glazed stoneware trades should make one bold to predict that the porcelain and white ware industry should also prove profitable, if only the necessary technical and skilled labour be organised. The ceramic industry in European countries as compared with China and Japan is of comparatively

recent origin and owes its development in no small measure to the initiative and encouragement of the state. Before the great war of 1914–18, England and America were dependent to a large extent on Germany and Japan for chemical porcelain ware. An instance of what state initiative and enterprise could do to the promotion of a new industry is to be witnessed in the steady development of the Royal Worcestor Porcelain in England in the years after the war. Millions of pounds were spent by the British exchequer for research into the manufacture of chemical porcelain under the direction of late Dr. J. W. Mellor.

For any mineral industry a complete knowledge of the country's resources of raw materials is essential. The nature and location of the deposits, the quantities available, the chemical and physical characteristics of the materials, etc., these are the essential particulars that require careful investigation, before any large scale industry is started. Every country of the civilized world has been taking stock of its mineral resources and industrial possibilities with a view to maintaining national self-sufficiency in regard to essential supplies. It must be agreed that the question of an all India Mineral Survey should prove stupendous from the financial and other aspects for any one institution to take up. It cannot, however, be dismissed as being out of the pale of practical achievement. The immensity of the task necessitates the full co-operation and co-ordination of all the available scientific and technical facilities in the country, if real progress is to be achieved. With a number of Universities, research

institutes, and provincial Departments of Industries spread over the country and with the co-operation of the All-India Geological Survey it should be possible to bring the question of an All-India Mineral Survey within the region of practical realisation, if only the co-operation of the staffs of all such schools can be enlisted. With the advent of the Board of Scientific and Industrial Research, the goal of increased co-operation and contact between the various scientific institutions has been brought nearer. The different scientific and technical institutions may be addressed as to exactly what each one of them can do in the matter of each industry. Every institution willing to co-operate may be assigned a definite region to operate; thus the work of survey will be carried out by men familiar with the local conditions, resulting in the rapid and efficient collection of fundamental data with the minimum expenditure on travelling and incidental charges. According to this plan the number of workers available is greatly increased and the resources of several institutions harnessed to a single purpose. It would not be difficult to find scientific men of enthusiasm and sacrifice in the different institutions all over the country, who would be willing to undertake this kind of survey besides their regular duties. In this way the capital and recurring expenditure on money and equipment will greatly be reduced, it being necessary only to supplement the already existing facilities in the respective institutions. In this way the author believes that the question of an all India Mineral Survey can be approached. What is required in a great sub-continent like India is a survey on a *regional basis* conducted with the coordinated effort of

several institutions, the Geological Survey, the Universities, the Research Institutes, and the several provincial Government Departments, similar to the work conducted in the United States of America, by the various State Geological Surveys, the U. S. Bureau of Mines, the U. S. Geological Survey, the U. S. Bureau of Standards, the different Universities and the many institutions of a private character like the Carnegie Institute, and the Mellon Institute. The chief point to be noticed is that if the work is conducted on a regional basis by men familiar with the locality and the terrain, it can be completed more expeditiously and efficiently and with much less expenditure than if it were carried out otherwise.

It was in this spirit that the ceramic survey of the Andhra districts has been undertaken by Dr. G. Gopalarao of the Chemistry Department, of the Andhra University with the kind encouragement of the Vice-Chancellor, Dr. Sir C. R. Reddy, M.A. (Cantab), D. Litt (Andhra). The work of touring and survey was undertaken by the author in the Summer, Michælmas and Christmas Vacations. In the work of analysis and ceramic tests, the author was assisted by Mr. N. B. V. Krishna Rao, M.Sc.

After the end of the first year, the work had to be suspended due to paucity of finances of the University. Within the available time of one year the author could complete the survey of outcrops in the Vizagapatam and Godavary districts.

In the Vizagapatam district good china clay can be got from the white decomposing rock occurring on the Bennavolu hill in Chodavaram taluq. We carried out chemical analysis and ceramic tests on the white clay

obtained by washing the rock powder. We believe that the material is suitable for the manufacture of porcelain, semi-porcelain, china, etc. At Bhogapuram in the same taluq, a white rock occurs on the hill. At Balighattam, in the Narasapatam taluq, a buff colored clay is obtained in the fields on the banks of the river Varahanadi. The clay is lean, burns to a red body but is sufficiently refractory; vitrification begins at about 1200°c. This clay will be useful in making red vitrified flooring and and roofing tiles, stoneware pipes, etc. At Pakalapadu in the same taluq, we get a red burning clay with vitrification point at about 1160°c. At Yerravaram about five miles from Narasapatam, there is an extensive deposit of a white rock which in composition resembles the English Cornwall Stone. The Cornwall stone is used by English potters in preference to felspar as a flux for the vitrification of earthenware and china bodies. It has the special advantage over felspar that it does not squat so easily. Cornwall stone is also an important factor in the manufacture of Pottery glazes. At Dasannapeta, there are deposits of a white disintegrating rock, which on washing yields a buff burning clay and white sand. The clay can be employed in the manufacture of white earthenware, china, etc. The sand is fine grained, low in iron and hence can be used with considerable advantage in the glass industry. The occurrence of white decomposing silicate rocks similar to the Dasannapeta rock appears to be a general feature of the Vizag district. Particular mention is to be made of the deposit on the top of the Punyagiri Hill at Sringavarapukota; this yields a pure white china clay and sand on washing. At Kinthada near Kotapadu there are

deposits of a white rock which we find, in composition, to be similar to the Cornwall Stone. At Koduru, a small Village near Garividi Railway Station on the Bengal Nagpur Railway, famous for its manganese mines, we get large seams of a non-plastic, highly refractory clay.

In the Vizag district graphite occurs at several localities: Modangi, Suritisila, Nerellavalasa and Thonam near Salur, at Kothakota on the Chodavaram-Narasapatam road, at Kasipatnam near Sringavarapukota and other places. It should prove a useful and profitable invesitgation to examine the suitability of the graphite from these different places for the manufacture of graphite crucibles, etc. Graphite crucibles are used for melting various metals like aluminium, copper, etc., and alloys like brass, bronze, etc.

The district of Vizagapatam has long been known for its extensive deposits of fairly rich manganese ore. The Kodur mine is the first to be worked in India. Other deposits have since been opened up, at Kantakapalle, Donkinavalasa and Salur. The author has made numerous experiments and found that manganese ores containing a high percentage of manganese can be used in the production of jet black, and brown glazes, in the decolorisation of oils (according to a process patented by the author jointly with Mr. T. V. Subba Rao) and in the manufacture of driers for paint oils.

In the Godavary district at a place known as Bommurumetta two miles from Rajahmundry Railway Station, a plastic white clay occurs in plenty. This burns to a dense pale yellow body. This has been found, suitable for the manufacture of stoneware jars, pipes

and white earthenware. At Puniakshetram, eight miles from Rajahmundry, we have extensive deposits of a very plastic clay. This burns to a dense pale grey body. Our experiments show that this clay is very suitable for making stoneware jars, pipes and sanitaryware, where an opaque glaze is employed. At Dwaraka Tirumala, eighteen miles from Bhimadole Railway Station, on the M. & S. M. Railway, there are thick deposits of plastic ball clay on a hill. This burns to a dense white body and this is suitable for the fabrication of earthenware after admixture with suitable china clay, felspar, etc. Graphite is also available in the Godavary District.

On the east coast, between Madras and Calcutta, a distance of over a thousand miles there is not a single factory devoted to the pottery industry. There is need for the erection of two or more factories. Rajahmundry and Vizagapatam seem to the author to be the most suitable places. Rajahmundry is at the head of a net work of canals which facilitate the distribution and sale of the finished ceramic products throughout the rich deltaic tracts. Within easy reach of Rajahmundry are the ball and pipe clay deposits of Dwaraka Tirumala, Bommurumetta and Puniakshetram. Felspar can be had from Nellore. Near about Vizagapatam we have rich deposits of china clay bearing rocks and felspathic rocks. The contiguity of a modern Harbour, and the location of a central Electric Power Station, the Headquarters of the University, etc., make Vizagapatam the potential industrial centre of Andhra. It is time that Andhra financiers and industrialists shake off their traditional conservatism and start porfitable and nation building industries. The Andhra districts are rich in

mineral resources. China clay deposits are also available in the Nellore, Guntur, Chittoor and Kurnool districts. Felspar and quartz are available in plenty in the Nellore and Kurnool districts. Soapstone the compact, structureless variety of talc, a silicate of magnesium [$H_2Mg_3(SiO_3)_4$] occurs in the Nellore and Kurnool districts. In the ceramic industries, talc is used in sagger bodies, glazed wall tile bodies, electrical porcelain, etc. Large slabs are cut into panels for switch boards, table tops, laboratory and kitchen sinks, linings for furnaces and stoves, tips for gas burners, on account of the fact that steatite is a bad conductor of heat, electricity, and is resistant to acids and corrosive melts. In the form of fine powder steatite is used as a filler for paper, textiles, rubber, soap, paint, etc., as a polishing agent for glass, leather, food grains etc. India is the Empire's largest producer of talc. The ruby mica of the Nellore district is an important commercial commodity for export. It is unfortunate that this strategic mineral is exported at cheap rates without being utilized for different manufactures in India. Bihar and Nellore are the centres of mica production in India, and India is the world's largest exporter of muscovite mica. Barytes, from which various barium compounds used in the ceramic industry are made, is available in large quantities in the Cuddapah, Anantapur and Kurnool districts. There are many other economic minerals available in the Andhra districts, besides those mentioned in this article. It is necessary that the Government of the Province, the University and the local bodies organise a survey of the mineral wealth of Andhra.

THE PALÆONTOLOGY OF THE RAJAHMUNDRY AREA :—THE FOSSIL FLORA

BY

MR. K. SRIPADA RAO, M.Sc., F.G.S.

(*University of Mysore, Bangalore.*)

The fossil plants of the Rajahmundry area are associated with two distinct geological formations—(1) The Upper Gondwanas (Jurassic) and (2) The Intertrappeans (Eocene).

1. The Upper Gondwana Flora :

The Upper Gondwana rocks occur as small isolated patches and extend from Thalapudi (17,7 ; 81,44) about ten miles from Rajahmundry to beyond Golapilli (17,43 ; 80·58) west of Ellore—a distance of nearly sixty miles. They consist of about 300—400 feet of variegated sandstones and shales. King (1880, 1889) has classified these rocks into the following three sub-divisions :—

1. Tripetty sandstones.
2. Raghavapuram shales.
3. Golapilli sandstones.

Each of these sub-divisions has been named after the locality where the rocks are typically developed. The Golapilli and Raghavapuram rocks contain the plant remains.

The plant fossils are of the nature of carbonaeous leaf impressions and are found in a fair state of preservation. The plants belong to three distincts families :—

Filicineae, *Cycadaceae*, and *Coniferae*. Of these families the *Filicineae* is poorly represented while the *Cycadaceae* and *Coniferae* are fairly abundant. The first and only description of these plant remains is by Feistmantel (1877). The following tabular statement gives the distribution of the various plants in the Golapilli and Raghavapuram areas :—

	Golapilli.	Raghavapuram.
Filicineae :	**Alethopteris**	**Dichopteris**
	Pecopteris	**Pecopteris**
	Angiopteridium (2)	**Angiopteridium (2)**
		Pachypteris
Cycadaceae :	**Ptilophyllum (2)**	**Podozamites J.**
	Dictyozamites	**Otozamites**
	Pterophyllum (4) R.	**Ptilophyllum**
	Williamsonia	**Pterophyllum**
Coniferae :	**Palissya (2)**	**Taxites (2) J.**
	Cheirolepis R.	**Gingko**
	Araucarites R.	

TABLE I.

(The figures in brackets indicate number of species ; R—Characteristic Rajamahal form ; J—Characteristic Jubbulpore form).

While the Golapilli plant fossils are typical Rajamahal forms, the Raghavapuram fossils include a few species allied to the Jubbulpore flora, in addition to the normal Rajamahal types It is on account of this peculiar association that the sequence of the Upper Gondwanas of the Rajahmundry area is very interesting as well as instructive.

The Rajahmundry Upper Gondwana flora has long been considered to be very similar to the flora of the Rajamahal Hills. Both these are characterised by the preponderance of ferns, cycads and conifers and by the absence of species characteristic of the Cretaceous. The recent work of Dr. B. Sahni (1938) and his colleagues has proved conclusively that the Rajamahal flora is essentially a Jurassic flora. Even though the evidence of the Rajamundry plants is in favour of a Jurassic age, the recent discovery by Dr. L. F. Spath (1933) of some cephalopods of Lower Cretaceous affinities, from the Raghavapuram (?) shales, has emphasised the need for a critical re-examination of the Rajahmundry Upper Gondwana flora. Until this is done no definite conclusions can be drawn regarding the age of this flora.

2. The Inter-trappean Flora :

The Inter-trappean beds of the Rajahmundry area consist of two facies—one estuarine and the other marine. The estuarine facies is made up of marls and limestones and is well-developed near Kateru (17, 3; 81, 48), where the inter-trappean band has a thickness of about fourteen feet. The marine facies occurs in the Pangadi (17, 1; 81, 41)—Dudkur (17, 2; 81, 37) region and consists of fossiliferous limestones intercalated with clayey bands.

The plant fossils in these rocks were first discovered by S. R. N. Rao and K. S. Rao (1935) about six years ago. They belong to two families of calcareous Algae—the *Dasycladaceae* and the *Charophyta*.

The *Dasycladaceae* are marine algae and are found in the limestones of the Pangadi-Dudkur region. Seven genera belonging to this family have been reported by S. R. N. Rao and K. S. Rao (1935, 1936, 1937, 1938, 1940). The following table gives the names and the stratigraphical distribution of the Rajahmundry *Dasycladaceae* :—

	Trias.	Juras.	Cret.	Pal.	Neog.	Holo.
Holosporella	?					
Dissocladella ...				*		
Neomeris (4) ...		-	*	*	*	*
Terquemella ...				*		
Acicularia ...				*	*	*
Acetabularia ? ...						
Halimeda ? ...						

TABLE II.

(The figures in brackets indicate the number of species ; * indicates that the species is represented).

The *Charophyta* are found in abundance in the estuarine marls of Kaleru. They consist mostly of detached 'fruits' (*oogonia*) and a few stem fragments.

Thirteen species of *Chara* have been described recently by K. S. Rao and S. R. N. Rao (1939). The following table gives their stratigraphic distribution :—

	Cret.	Pal.	Eoc.	Olig.
C. wrightii ...			*	
C. helicteres ...		*	*	*
C. medicaginula ...			*	*
C. caelata ...			*	
C. vasiformis ...			*	*
C. turbinata ...			*	
C. strobilocarpa ...			*	
C. subglobosa ...				*
C. oehlerti ...				*

TABLE III.

(* Indicates that the species is represented).

In addition to the nine species of Chara tabulated, the following four new species have been established :—

C, indica, C. rajahmundrica, C, sahnii, and C. sampathi ;

The *Charophyta* and the *Dasycladaceae* of the Rajahmundry area have proved to be of considerable importance in the elucidation of the age of the Deccan Traps. (Sahni, 1934 ; 1940 ; Rao and Rao, 1935, 1936). The evidence of these algae points to an early Tertiary age.

Bibliography.

Feistmantel. O.

1877: Mems. Geol. Surv. Ind. Pal. Indica, II, I, 163, 191.

King. W.

1880: Recs. Geol. Surv. Ind., X, 56.

1889: Mems. Geol. Surv. Ind., XVI, 211.

Rao, K. S and Rao, S. R. N:

1939: Mems. Geol. Surv. Ind. Pal. Indica, n. s., XXIX, ii.

Rao, S. R. N. and Rao, K. S:

1935: Curr. Sci. IV, v, 324.

1936: Proc. Ind. Acad. Sci, III, ii, 157–165.

1937: (i) Recs. Geol. Surv. Ind., LXXI, iv, 397–400.

(ii) Anz. der Akad. der Wiss in Wien, Nr. XXI, 185–86.

(iii) Sitzungs. der Akad der Wiss. in Wien, Math-Nat. Kl, Ab 1 Bd. 146, s. 227–236.

1938: Curr. Sci., VI, viii, 376–377.

1940: Proc. Ind. Sci. Congr., III, 118–119.

Spath, L. F.

1933: Mems. Geol. Surv. Ind. Pal. Indica, n.s. IX, ii, 827.

Sahni, B.

1934: Curr. Sci., III, iv, 134–136.

1938: Proc. Ind. Sci. Congr., Presidential Address, Section of Botany.

1940: Proc. Ind. Sci. Congr., General Presidential Address.

A BRIEF SURVEY OF RESOURCES AND DEVELOPMENT OF POWER IN NORTHERN CIRCARS.

BY

MR. A. R. N. RAO, B.E. (MECH)., A.M.I.E.E.,
(Government Electricity Department, Bezwada.)

I. AREA.

The areas considered are the districts of (i) Kistna, (ii) Guntur, (iii) West Godavary, (iv) East Godavary, (v) Vizagapatam and adjoining Jeypore Agency (formerly in Madras Presidency and now transferred to Orissa.)

II. GENERAL.

Mostly it represents a rich strip of coastline varying from 25 miles to 50 miles except in Vizag and Guntur districts.

Two of India's large rivers flow through these areas discharging large volumes of water into the Bay of Bengal making the land very rich for agriculture.

There is an abundant natural wealth in still undeveloped forests and sparsely developed industries. Agriculture, mainly rice cultivation, is represented well, due to the large irrigation works and the delta.

Rice hulling and decortication of oil seeds and oil pressing are the main industries, barring the recently started Cement Factories. A Paper Factory is still fighting for its life.

A good harbour has been built up at Vizag but not utilised to the extent it could be.

III. POWER RESOURCES.

1. Natural—Hydro-Electric.

The following schemes have been under investigation :—

(*a*) *Chettipet-Godavary Canal Fall* (*near Rajahmundry*) :—About a 1,000 H.P. is anticipated to be developed for about 10 months in the year, and by itself cannot obviously form a stable supply unless supplemented by a large-sized steam station.

(*b*) *Lammasingi Scheme* (*near Narasapatam Agency in Vizag district.*)—Investigations have shown that the quantity of water available cannot economically be harnessed. Further investigations have therefore been dropped for the present. The probable future installation will be 2 Nos. 4,500 K. W. Sets.

(*c*) *Godavary Barrage* (*near Polavaram*) :—A dam 4,500 feet long and 170 feet high near Polavaram is under investigation as a combined Irrigation and Hydro-Electric Project. About 1,28,000 K. W. of continuous power would be available.

(*d*) *Sabari Scheme* :—This is to be an alternative development to Polavaram. A dam is under investigation across the Sabari, a tributary to Polavaram. This will also be a combined Irrigation and Power Project. Power possibilities are 17,000 K. W. of continuous power.

(*e*) *Machkand* :—This is to be an independent Hydro-Electric Project. The first stage of development envisages the installation of 3 Nos. 6,250 KVA units. Sabari or Machkand Scheme, when materialised, will operate

in conjunction with the existing steam plants at Bezwada and Vizagapatam.

(*f*) *Kolab* :—5 Units of 11,500 K. W. each are likely to be installed as a result of preliminary investigation.

(*g*) *Tungabadra Project* :—Complete details are not available. This is to be a combined Irrigation and Hydro-Electric Scheme. Total power available will be 9,640 K. W. Inclusive of secondary and tertiary power about 16,000 K. W. would be available. The tertiary power, if developed, will have to be supplemented by steam plant.

The power possibilities are given in the following table :—

Details of power possibilities in the Andhra areas.

Item No.	Name of site	District.	Nearest Town and distance.	Fall in feet.	Continuous flow in cusecs.	Continuous power to be developed.
1.	Chettipet Canal Falls.	West Godavary.	Rajahmundry.	...	...	1,000 H.P.
2.	Lammasinghi.	Vizagapatam	Narasapatam Agency.	...	...	4,300 K W.
3.	Polavaram.	East Godavary	25 miles above Dowlaishwaram in the Godavary.	80	12,000	1,28,000 K W.
4.	Sabari.	...	Chintur. 18 miles above Polavaram where the Sabari joins the Godavary	50	2,500	17,000 K.W.
5.	Machkand.	Now in Orissa Province.	25 miles from Jeypore	750	100	10,000 K.W. More than 30,000 K.W. (with storage).
6.	Kolab-dadi.	Do.	Jeypore.	770	840	57,500 K.W.
7.	Tungabhadra.	...	...	...	...	9,640 K.W.
8.	Tetliguma (Lower Kolab).	Now in Orissa Province.	Jeypore. 38 miles.	200	900	15,300 K.W.

2. Other sources.

(*a*) *Rice Husk.*—The acreage under irrigation of paddy in the Circars is estimated at about 30,90,330 acres. The total estimated annual yield of paddy is about 22,85,540 tons. This is expected to yield about 5,71,210 tons of husk. Allowing an average thermal efficiency of 10% as in a good power station, this can yield 5,70,00,000 units or 7,00,00,000 H. P. hours.

(*b*) *Decorticator Husk.*—The annual groundnut crop is estimated at 2,21,400 tons. This yields about 55,360 tons of husk. This can yield about 2,10,00,000 units at 10% thermal efficiency.

(*c*) *Molasses.*- There are seven Sugar Factories in this area, producing molasses to the extent of 6,200 tons which gives 3,72,000 gallons of power alcohol.

3. Wind and Wave Power.

The facilities for wave power are not considerable as the rise of tide is about 5 to 6 feet and storage facilities are not many.

Similarly wind power is also not economically utilisable on a large scale with the present development of plants.

4. Forests.

Though a little of the wastes could be used for suction gas or production of charcoal, the system of denudation of forest will result in tragic consequences like soil erosion, floods, etc.

5. Special Conveyance.

The districts may be said to be fairly well-served with cheap and economical conveyance except in the

interior. Generally canal communication is well-developed and is also cheap.

IV. DEVELOPMENT.

(*a*) At present most of the power installed is for rice milling for exportation, and decortication of oil seeds. The general trend after the installation of two thermal stations of Bezwada and Vizagapatam systems, are to decentralise the big Rice Factories and shift them as small units to villages. The irrigation and pumping is also finding a good favour. In Bezwada area about 10 Mills at 500 H.P. have been connected.

(*b*) *Typical Cost Data.*—Generally it may be seen that the present cost of energy generated in a Central Station pays to transmit to villages and compete succesfully with husk burning Boiler

There is a general impression that a husk burning factory should normally be cheaper than a factory supplied with power from electrical or other sources. This is not generally the case. This can be seen by the simple fact that size for size, a given Rice Mill burning rice husk is being competed by its neighbour using crude oil Engines, the underlying reason being the low capital charges of oil engines and its maintenance cost, ease of starting, price obtainable for husk, etc. The same thing applies for groundnut husk.

Each individual capitalist cannot economically spend more on men and capital to improve thermal efficiency. The lubricating oil and maintenance charges form heavy burden as also the capital charges. Sometimes, difficulty of getting good water for boiler makes the boiler job also costly.

It may, therefore, be not very optimistic to consider that with the advent of Hydro-Electric Power and lower tariffs the oil Engines and individual husk burning boiler can be converted without much inducement in this area.

The question then arises, whether it is to be attempted straight off, and, if so, what are the advantages and disadvantages. These are tabulated in the enclosed statement (*see* Appendix).

A glance will show that a major problem will be the disposal of mountains of husk which are now being burnt off So again we may come to a stalemate, if scientists do not take notice from now and carry on research for the proper utilisation and obtaining good price for husk.

Varying suggestions can be put forward :—

(i) Treat the husk by some chemical process to make it less voluminous and then press it into briquettes for economical transport.

(ii) Develop the husk briquettes as a domestic fuel replacing to a large extent wood fuel. This has a national advantage. It relieves de-forestation and improves soil and retention of water and reduces floods thus increasing crop value grown.

(iii) Use of these briquettes for tobacco curing or turmeric boiling, and other indigenous waterheating is to be encouraged.

(iv) Another use is to treat and digest the husk in each factory on a small scale and convert into crude pulp,

compressed and sold to manufacturers of celotex boards —a new industry to be started in a central place. Special research in digesting and development of machinery on a small scale, suitable to the pockets of ordinary ricemill owners is indicated. Husk contains a large percentage of silica, and special investigation is necessary for its adaptation.

In all these items a planned and systematic development is called for.

(*c*) *Basic Industries.*—Large scale basic industries like vegetable oil products or hydrogenation of oil, can be started in Guntur or Krishna districts and one in Vizianagaram where decorticator and oil pressing is being carried on successfully. Soap industry is also indicated.

Other basic industries like the manufacture of fertilisers can be started near Vizagapatam and very near Kolab Hydro-Electric Scheme. Extraction of aluminium from bauxite can also be started in the same district from ore got from Central Provinces.

V. CONCLUSION.

All these indicate that very soon Hydro-Electric power is bound to come up and alter the country's outlook. Generally it is well-known for its improvement of cottage industries and irrigation pumping.

From now we should prepare the ground, through Exhibitions, Museums and other educative media and arouse the public consciousness of the larger response

at hand, which they could, if they want, take advantage and improve generally.

Large private capital can be attracted in the area but past experience shows that unsatisfactory management has frozen and made the capital shy. To get over this, the State could intervene and subscribe (at least nominal value) in token of their interest in the enterprise and create confidence in the minds of investing public.

In the next 6 to 10 years we should be able to see far reaching strides in the development of this area.

APPENDIX.

TYPICAL DATA—FOR ELECTRIC DRIVE OF RICE MILL (as in 1940).

Normal work of 3,000 bags of paddy per month.

100 bags of paddy of 168 Lbs. each, releases 90 bags of husk.

25 bags of husk = 1 bandy of husk.

8 bandies of husk = 1 bandy of ash (Burnt husk).

One hundred bags of husk at an average rate of Rs. 3-2-0 per bandy.

One bandy of ash at an average rate of Rs. 2/- per bandy of ash.

3000 bags of paddy = 2,700 bags of husk
(@ Rs. 3-2-0/100 bags.)
= 13½ bandies of ash.

(A) Value of husk per month (with elctric drive),
= 27 × Rs. 3—2—0.
= Rs. 84—6—0.

(B) Value of ash per month (with steam plants).
= 13½ × Rs. 2/-.
= Rs. 27/- per month.

I. With elctric plant for the Rice Mill.

Total cost of electric plant (50 h. p. installation)

Cost of Motor equipment = Rs. 1,500/-

Cost of Service Connection = Rs. 500/

Total. = Rs. 2,000/-

(*a*) Interest on capital @ 6% per annum. = Rs. 10—0—0 per month.

(*b*) Depreciation on plant @ 5% per annum. = Rs. 8—4—0 per month.

Total. = Rs. 18—4—0 per month.

(*c*) $1\frac{1}{3}$ *unit is consumed for every bag of paddy shelled and hulled thrice complete, with electric drive.*

Therefore units consumed per month of 3,000 bags of paddy = 3,000 × $1\frac{1}{3}$ = 4,000 units per month.

Cost of energy per month.

= 3,000 + 750 annas.

= 3,750 annas.

= Rs. 234-6-0 per month.

Total cost per month inclusive of interest on capital and depreciation.

= Rs. 234—6—0 + Rs. 18—4—0.

= Rs. 252-10—0 per month.

(*d*) *Deduct value of husk* per month with electric drive.

Net total cost per month with electric drive

= Rs. 252—10—0 - Rs. 84—6—0.

= Rs. 168— 4—0 per month.

for shelling and hulling thrice 3,000 bags of paddy of 168 lbs. each.

II. With steam plant for the Rice Mill.

Total cost of steam plant required for the Rice Mill = Rs. 10,000—0—0

(*a*) Interest on capital @ 6% per annum. = Rs. 50— 0—0 per month.

(*b*) Depreciation on plant @ 5% per annum. = Rs. 41—10—8 per month.

Total. = Rs. 91—10—8 per month.

(*c*) Working charges per month (with steam plant) for 3,000 bags of paddy per month.

(average work of 15 working days per month).

Cylinder oil, shafting oil etc.	...	Rs. 40—0—0	P.M.
Driver	...	Rs. 16—0—0	,,
Coolies for husk etc.	...	Rs. 10—0—0	,,
Repairs (average).	...	Rs. 34—0—0	,,
Licence and Misc., charges	...	Rs. 8—0—0	,,
Total	...	Rs. 108—0—0	,,

Total cost per month inclusive of interest on capital and depreciation. = Rs. 91—10—8 and Rs. 108—0—0.
= Rs. 199—10—0 per month.

(*d*) *Deduct value of ash* per month with a steam plant.

Net total cost per month with steam plant
= Rs. 199—10—8 – Rs. 27—0—0
= Rs. 172—11—0 (nearly) per month.

for shelling and hulling thrice 3,000 bags of paddy of 168 lbs. each.

Connected Horse Power.

S. No.	Particulars.	Guntur Dist.	Kistna Dist.	West Godavary Dist.	East Godavary Dist.	Vizagapatam Dist.
		H. P.	H. P.	H. P.	H. P.	H. P.
1.	Steam ...	7,000	7,000	3,000	3,000	7,000
2.	Oil ...	1,000	1,500	2,000	2,500	2,000
3.	Electric ...	1,500 (Kistna Cements)	4,000	...	1,750	3,000
4.	Existing Total H.P.	9,500	12,500	5,000	7,250	12,000

HYDRO-ELECTRIC SCHEMES IN THE ANDHRA AREA

BY

MR. D. SEETHAPATHIRAO, B.A., B.Sc.
(Andhra University, Waltair.)

This paper deals with the Hydro-Electric Schemes in the Andhra area. The scope of this subject is restricted here to only those possibilities existing in the Northern Circars. On the necessity for developing the Hydro-Electric resources, there is no need to dwell at length, as it is well-known and widely accepted that the fuel resources should be conserved as much as possible for other industries in which their use is absolutely essential. Especially, the coal and oil resources of a country should not be exhausted by utilising them for purposes of power production, when this could be done cheaper form the power available from the Hydro-Electric Schemes.

There are four main Hydro-Electric Schemes in this area :—(1) Lammasinghi, (2) Nagavali Scheme at Rayagada, (3) Kolab and (4) Chettipeta. Each one of these schemes in the above order are dealt with below :—

Of the above, the first three, *viz.* Lammasinghi, Nagavali and Kolab are in the Vizagapatam district as it existed prior to the formation of the Orissa Province.

Lammashinghi Scheme :—This is in the Narasapatam Hills, and is a high head scheme, the gross head available being 1,500 ft. The ultimate development

capacity of this scheme is 30,000 H.P. consisting of four units of 7,500 H.P. impulse-wheels.

Nagavali Scheme :—This is a small one, situated within two miles of the Rayagada Railway station on the Vizianagaram Raipur line of the Bengal Nagpur Railway. This is a simple and cheap scheme with an estimated yield of 1,000 H.P. continuous. The head available is 80 ft. No further details are available about this scheme.

In Jeypore and Koraput areas, there are a number of Hydro-Electric possibilities on the rivers, Kolab and Machkand, at Bagra and Duduma falls These lie actually in the Orissa Province. But the power markets for these schemes exist in the Vizagapatam and Godavari districts and very little in the Orissa Province. It is worth while, therefore, for the Madras Government to settle the necessary inter-provincial questions and develop these schemes.

Kolab Scheme :—This consists in utilising the waters of the Kolab and the Dadi rivers which drain a catchment of about 600 sq. miles. The Dadi alone has a catchment of 150 sq. miles. The minimum run off from these catchments is estimated as follows :—

Kolab.	8,400 m.c. ft.
Dadi.	2,800 m.c. ft.

The minimum flow in the river gauged in May 1919, an exceptionally dry season following poor monsoon was 100 cusecs. There are two dam sites, one on the Kolab and the other on the Dadi rivers capable of independent

development. This is an advantage as it would facilitate the development of the scheme, in stages. Allowing a possible storage of $\frac{7}{12}$ of the run off of the above catchments, the constant available discharge would be as follows :—

	Cusecs.
Kolab Flow	75
„ Storage.	210
Dadi Flow	25
„ Storage	70
Total	380

The head available is 600 ft. and the continuous power available would be 14,000 K.Ws. or more on the lowest computation.

Given the above flood regulation by storage, the river could be developed by means of lifting dams to the extent of a further 15,000 K.Ws. or more in the course of its rapids down below.

On this river, there is yet another fall of 210 ft. at Tetligumma with a possible power development of 4,000 K.Ws. continuous. The total power available therefore would be 33,000 K.Ws. from this river.

Machkand Scheme :—The Machkand river has a fall of about 540 ft. at Duduma Known as Duduma falls. Above these falls there is a possibility of storing water to the extent of 3,300 m.c.ft. This storage would give a continuous discharge of 190 cusecs. The lowest recorded ganging of the river flow was 100 cusecs. The minimum continuous supply of water would therefore be 290 cusecs.

With an additional 40 ft. head that could be obtained from the storage dam, the total available head would be 580ft. The power that could be developed is 11.000 K.Ws. continuous. This is only a fraction of the power available on this river. If the Duduma were harnessed and the flood waters regulated, there would be a minimum flow of 300 cusecs down the river. There is at least a 1,000 ft. of fall available which, given the initial flood regulation, would facilitate the development of at least 10,000 K.Ws. continuous. The nature of the ground is such as to facilitate the impounding of all the run off of the above catchment and if this is proved possible by actual survey, this river would be capable of supplying power to the extent of nearly 50,000 K.Ws. instead of the 21,000 K.Ws. estimated above.

A conservative estimate of power from the Kolab and the Machkand Schemes would therefore work out to a total of 50,000 K.Ws. continuous.

The Details of the Kolab Scheme,

A reservoir site for the dam on the Kolab river was found by Mr. Tate. The dam at this site would be 660 ft. long and 80 ft. high. The height of the Dadi reservoir would be only 50 ft. and of practically the same length.

From the dam, the water would flow along the natural bed of the river over a distance of 5 miles, where a diversion weir has to be provided to divert water into a canal of two miles length. This canal leads the water to a regulating reservoir of 60 m.c.ft. capacity. The water from the reservoir would be taken through a tunnel

3,000 ft. long to the fore-bay from which the water would flow down through pipes of about 2,500 ft. length running on the spur of the left bank of the stream to the power-house. The power-house site is situated near Bodligura village. The water from power-house would be let into the river back again.

Details about the Machkand Scheme.

The catchment above the falls of the Machkand river is 904 sq. miles. The average rainfall is about 50 inches. The lowest conceivable run off from the catchment is several times the highest possible storage. The question therefore is only one of surplussing the excess, for which there are ample facilities.

There are two alternative dam sites. The one examined by Mr. Sneyde is 1½ miles above the falls and the other by Mr. Tate 2½ miles above the falls. Mr. Tate's proposal gives an additional head of 40 ft. Both the dam sites have solid granite foundations. The capacity of the lake would be 3,300 m.c.ft. The land submerged is of little value.

The original reconnaissance suggested a pick up weir about 300 yds. below the main dam, for feeding an open channel ¾ mile long. It is possible that with such a short distance from the reservoir to the fall, a pipe-line run directly off the reservoir with a surge tower above the fall would be preferable. If the upper dam site is found better, an open channel would be necessary. Two fore-bay sites exist, the better one entailing a loss of 15 ft. head. There is no natural site available for the power-house, but one has to be excavated on the rock, under-ground, away from the fall.

With so much power available, with facilities for development, there is no doubt about the schemes being successful. With the advent of the Kolab Scheme, it would be possible to develop the following industries, as power would then be available cheap :—(1) Fertilisers, (2) Insecticides, (3) Alloy Steels, (4) Magnesium metal, (5) Titanium Oxide and (6) Aluminium. But before the development of these big loads which would naturally take some time, it is worth while investigating whether there is any initial load in the area to be served by these schemes. The area of service may be said to be the area north of the Godavari river. The initial load that is likely to be available in the area is estimated as follows :—

Small Mill loads.	1,500	K.Ws.
Big Mill loads.	1,500	„
Municipalities, Unions and Major Panchayats.	1,500	„
Agricultural load	1,500	„
Ship building yard.	1,000	„
Mining load.	200	„

Of the above, the small mill loads would consist of the Oil-engine-driven decorticators, oil expellers and rice hullers. The rice hullers working on steam power produced by firing husk, have not been included. If the anticipations in the 1939-40 administration report of the Electricity Department materialise and the rice mills convert to electric power, the load would be far in excess of the above estimates.

There are three big mills in this area now producing their power requirements from coal. It may be

reasonably expected that these would change over to Electric drive by tactfully dealing with the managements. The total load of the two jute mills is estimated at 600 K.Ws. The paper mills at Rajahmundry with a 1,200 K.Ws. steam-turbo-alternator may also be expected to take up electric power from the Hydro-Electric stations. The load from these mills would be at least 1,500 K.Ws. The recently started Tobacco factory at Anaparthy would contribute an additional load and this has not been included in the above load.

It is reliably understood that the shipbuilding yard at Vizagapatam has already informed the Vizag Electric Supply Corporation that its power requirements would be 1,000 K.Ws. and this in its initial stages.

It has been clearly mentioned that these schemes serve the Old Madras Province to the north of the Godavari river. This is an agricultural area without irrigational facilities to the north of Pithapuram. But many taluks to the north of Pithapuram contain subsoil water suitable for irrigation fairly near the ground level. The agricultural population here as elsewhere in India, are ignorant of the uses of the electricity. With proper propaganda and with the co-operation of the department of agriculture, a pumping load of at least 1,500 K.Ws. could be very easily developed. Even without sufficient effort and demonstration by the Electricity Department, agricultural pumping loads have already been started at Bhimlipatam on electric drive. This would induce the owners of the neighbouring areas to use electricity. At Anaparthy a Tobacco curing factory has recently been started which would increase the

tobacco cultivation in the surrounding area. This is a dry crop, which requires watering by lifting water. This would supply an additional pumping load for electric power. In these circumstances, the 1,500 K.Ws. load may be considered to be a very modest estimate.

With such a load available, even initially, it should be possible to start immediately any one of the Jeypore or Lammasinghi schemes with the sympathetic support of those in charge of power developments. It has often been said, that the load is not developing in these areas due to its backwardness which would vanish if the development department is less ultra-cautious in its policy. At present, the Government is waiting for the load to develop of its own accord, instead of helping it to develop by its efforts.

That the Government is ultra-cautious is amply borne out by the load that has already developed even before the second year of their operation in both the Vizagapatam and Bezwada Thermal Scheme areas. To meet the increasing demands the authorities have already taken steps to increase the plant capacities. The same was found to be the case even in the Pykara Project. It is hoped that at least in the future schemes that await development, the Government would be less conservative in their estimations of load developing possibilities.

The Chettipet Scheme :—This is a low head canal fall scheme on the Godavari Western delta canal. The fall occurs near Chettipet, about 6 miles off the anicut. The drop available, is 12 ft. The water that flows through the canal is not constant, throughout the year

but varies from about a maximum of 1,500 cusecs to 500 cusecs in bad years. For 6 weeks in a year, the canal would be closed down. This is one of the chief disadvantages of this scheme. The flow in the various months in a year is as follows :—

July to November	...	1,500 cusecs.
December to February.		1,000 „
March to 15th April	...	500 „
15th April to the end of May	...	Nil.
June	...	500 „

The power available from the canal would therefore vary from 950 K.Ws to 315 K.Ws as follows :—

July to November	...	950 K.Ws.
December to February.		630 „
March to 15th April and June		315 „

To take up the entire station load during closure period it is necessary to provide a second-hand Diesel Engine stand-by plant. It would also be necessary to commission this plant to take the excess load on the Hydro-generating plant during the low water flow periods in the canal. The help that would be necessary from this stand-by plant is estimated as 20% of the units supplied during the months of December to February and June. During the months of March and up to 15th April, the help necessary is estimated as 45% of the units supplied. During the canal closure, 6 weeks period, 100% help would be necessary. The total units

generated by the stand-by plant on the above basis works out to 23·4% of the total units supplied by the station in a year with 950 K.Ws peak and 45% load factor.

The cost of the Hydro-generating plant, including power house, civil works, etc., have been worked out on the basis of costs of the Bhola power plant in the Ganges canal grid which is working under similar conditions.

An abstract of capital costs and annual charges worked out is given below :

CAPITAL COST.		Rs.
Hydro-generating plant	...	2,25,540
Power Station and Civil works	...	1,94,978
Transformer and Switch gear	...	74,145
Second-hand Stand-by plant	...	2,50,000
Total cost of the generating plant	...	7,44,663
Total capital cost including transmission line	..	11,49,663

ANNUAL CHARGES.		Rs.
Depreciation on Hydro generating plant including civil works	...	7,150
Depreciation on Transformer and switch gear	...	2,736
Depreciation on standby-plant	...	9,000
Annual salaries	...	28,300
Repairs, renewal, etc.	...	8,000
Miscellaneous	...	1,000
Cost of Fuel	...	23,400

		Rs.
Cost of Lubricating Oil	...	5,580
Total Annual charges	...	85,366
Total annual charges with transmission lines	...	1,09,630
Interest on total Capital outlay@ 5·5%		63,050
Total annual charges with interest	...	1,72,680

The depreciation of the plant was worked out by the sinking fund method taking the compound interest rate of 5·5% for the various lives of the plant components taken separately.

The sale price of power per unit would work out to 8½ pies, fetching a nett revenue of 5·5% on the entire capital outlay.

The price of power per unit is low and sufficiently competetive as compared with power from any other source in this area. The power from this station could be distributed in the Bhimavaram, Palacole, Narsapur, Tanuku and Nidadavole areas. It would be unwise to extend the area of supply further as the station capacity would then be insufficient to meet the further load developments. It is highly desirable, therefore, that the Government should at once take up the scheme and work it.

If the Sabari scheme now under contemplation for augmenting the summer flow of water in the Godavari river and canals comes into execution, the working costs of the standby plant, which are fairly high, will be reduced. It may reasonably be expected that the sale price per unit would come down to about 7 pies.

REFERENCES.

(1) Hydro Electric Survey of India, Vol. I by Barlow and Mears.

(2) Hydro Electric Survey of India, Vols. II and III by Mears.

(3) Progress of Science in India for the past twenty-five years.

(4) Report of the Department of Industries and Commerce for the Madras Province for the year 1939.

(5) Hydro Electric Practice in India, Vol. II—B.C. Chatterjee.

RESOURCES FOR ORGANIC CHEMICAL INDUSTRIES

Drugs and Insecticides

BY

PROF. T. R. SESHADRI, Ph. D., F.I.C., F.A.SC.

(*Andhra University, Waltair.*)

For the successful organisation of Organic Chemical Industries a large number of important items require close examination. As far as the raw materials are concerned the available resources can be studied under the following main heads: (1) Agricultural products, (2) Forest products, (3) Marine products. Under the first category rice, millets, cotton, sugarcane, tobacco, oil seeds and fruits may be mentioned as the most important, spices, fibre producing plants and starchy roots being of lesser importance. In connection with several of these raw materials the by-products assume great importance in industrial economy, as for example, rice husk, cotton seed, molasses and tobacco waste. Amongst forest products vegetable drugs, dyes and tans, gums and resins, bees-wax and bamboo are the most promising items though the importance of wood and the products of wood distillation as fuel and as the basis of chemical industries should not be ignored. The long coast line, with great scope for the development of fisheries, suggests possibilities for the utilisation of fish oils and sea weeds and other related products.

In this vast field of work related to the development of industries the following special lines have been studied in the Andhra University: (1) Vegetable drugs

and insecticides, (2) Fruits, (3) Wood distillation and power alcohol, (4) Dyes and tans, (5) Paper, (6) Oils and soaps and (7) Gums, resins and wax. Notes are presented relating to each of these.

Drugs.

The drug industry is probably one of the easiest of the chemical industries to organise, since, the margin of profit is fairly high and the technical skill of the scientific worker is far more important than the cost of raw materials. However, the easy availability of the necessary heavy chemicals, of the crude drugs and of containers and packing materials play a vital role in making the industry efficient. It seems that the organisation of the trade and the existence of a good market for the consumption of the products are by far the most important items responsible for the promotion of this industry. In this connection legitimate protection from undue foreign competition is quite essential till the industry has gained a secure footing. A well-protected and well organised drug industry is essential for the welfare of a nation and its importance was at no time realised so fully as at the present crisis of a world war.

For the location of this industry the neighbourhood of some of the large cities with good lines of communication and particularly with cheap waterways is preferable. By this means cost of transport is considerably reduced. Not only will the required bulk chemicals and raw materials be available cheap but the manufactured products can also be distributed at less cost. Except for one small concern, the Andhra Pharmaceuticals located at Bezwada, the Andhra districts are

particularly lacking in pharmaceutical concerns. The area possesses a variety of climates and soils. Consequently there is great scope for producing a large range of vegetable drugs. So far no authoritative surveys seem to have been made regarding the resources of plant drugs. Some of the most well-known are mentioned below.

The seeds of Strychnos nux vomica have been recognised for a long time as constituting one of the most important of drugs. The powdered seeds and decoctions made from them have been used in Indian medicine for dyspepsia and diseases of the nervous system. Extracts and tinctures and the pure alkaloid—strychnine—are official in the pharmacopoeias of various countries. Further the drug has a large use as an insecticide and rodent poison. Two well-known alkaloids, strychnine and brucine, are present in these seeds ; of the two the former is the therapeutically important substance. India holds the world's monopoly in this drug and a good portion of the supply is derived from the hilly and forest areas of the Andhra districts. The material is available very cheap but the cost of transportation is considerably high and hence it is best utilised for manufacturing purposes locally. The greater portion of the produce is now exported to the West. Some extraction is done by the firms in Calcutta and it is reported that fairly considerable quantities of the alkaloids are exported to Australia in the form of rodent poison.

A closely allied seed, Strychnos potatorum, is also available in these districts. It has no medicinal value

since it contains only brucine in small quantities. It is mainly employed for clarifying muddy water in rural areas.

Holarrhena antidysenterica is a small deciduous tree with white flowers. Its bark is quite famous as the Conessi bark or Kurchi bark. Its seed is also employed. The former is bitter and astringent, whereas, the latter is bitter only. They are particularly useful for amoebic affections of the intestines and are highly valued. Several preparations made from them are available in the market. The samples obtained locally are found to be of good quality. Careful chemical study of this drug, carried out particularly in India has revealed the existence of a larger number of alkaloids. Of these conessine is believed to be the most important. However, for a number of purposes the total alkaloids seem to work better. They have been used in the place of emetine and sometimes in combination with it.

The bark of Alstonia scholaris, also known as 'dita bark' has been reputed in Indian medicine as a tonic and as a cure for fever. It is claimed that it is very useful in the treatment of malaria. The Indian squill is easily available particularly in sandy areas near the sea and has been found to possess all the properties of the Mediterranean squill as expectorant, cardiac stimulant and diuretic. It has been used even in the Government Medical Stores for making galenicals and has been found to be quite satisfactory. It is much cheaper than the imported foreign varieties. The virtue of this drug is due to the presence of compounds known as cardiac glycosides.

Amongst other well-known drugs may be mentioned Hemidesmus indicus, also known as Indian sarsaparilla. The root is employed in large quantities as a tonic; it is in no way inferior to the true sarsaparilla. Cassia fistula also grows abundantly in these districts; its long pods are employed in the production of sweet laxatives and other parts are used for the treatment of black-water fever and similar ailments. Castor seeds form an important agricultural product of the Northern Circars. Still, high grade castor oil is imported in large quantities every year. A number of other drugs which are not so well-known seem to be in use. For instance Clerodendron serratum is collected in large quantities from the Narsapatam agency and sent to Calcutta and Bombay. The occurrence of good quality kaolin in the coastal districts may also be mentioned here.

Insecticides

India is largely agricultural and agricultural and horticultural pests of various types offer great difficulties to the agriculturists. Further, in view of the warm and highly favourable climate municipal and household pests form a serious menace to public health. In commerce the large store-houses have their own problems in storing grains and similar plant materials. There is therefore, great need for the supply of cheap insecticides and fungicides. Still, so far, no attempt has been made to foster a local industry to supply this demand.

Amongst the insecticides, compounds containing copper, lead and arsenic have been in use for a

considerable length of time and they still hold the field to a large extent. But recent trends in this line are towards the utilization of materials of plant origin. They are safer being toxic to the insects and other lower organisms and comparatively harmless to larger animals. Further, the use of agricultural and other byproducts has made the destruction of insect pests cheaper. In the following paragraphs attention will be directed to insecticides and fungicides of plant origin that are available in the Andhra districts whose resources are now under consideration.

Derris and Pyrethrum which are rightly recognised as the most important of the plant insecticides do not occur here. Efforts should be made to grow them in suitable localities. They will certainly form very important additions to the resources of this country. But various varieties of Tephrosia grow abundantly on waste land. The most important being Tephrosia purpurea, T. maxima and T. villosa. They all contain compounds belonging to the rotenone group. The leaves, seeds, stem and root barks have been examined. They are toxic to fish and though they are not very satisfactory, it is quite possible that by careful cultivation and selection their quality could be improved. The seeds of Cocculus indicus form another insecticidal material and the toxic principle present in them goes by the name picrotoxin. They are in common use for the destruction of lice and for poisoning game and fish. The coastal areas abound in the trees of Pongamia glabra. Various parts of this tree are in use from time immemorial to deal with insects. The leaves have been

employed for the preservation of grains in paddy stores. The oil is reputed for its medicinal properties and it has been found that a soap prepared from it is very useful in the preparation of insecticidal sprays. The Andhra districts form an important area for the growth of the castor plant. It is believed that the very existence of these plants in the vicinity of a house keeps it free from mosquitoes. Whether this is well founded or not, the castor leaf is an important material to be used as an insecticide. It has been extensively tried in America, especially in citrus groves, and found effective in repelling aphids, mosquitoes, white flies and rust mites. Cashewnut is an important product of the coastal districts and if the isolation of the kernel is carried out under proper conditions large quantities of the shell oil can be obtained as a byproduct and this is highly useful for the preservation of various materials, particularly wooden structures, from the attack of termites. The value of nux vomica as a rodent poison has already been mentioned.

Great importance should be attached to the utilization of tobacco waste as an insecticidal material. Tobacco is a very important crop in most of these districts and particularly so in Guntur, Kistna and Godavari. All tobacco waste obtained in the course of manufacture and material that may be considered as of low quality can be profitably employed for the production of insecticides. In powder form it is diluted with inert materials such as clay and used for dusting. Though tobacco extracts are employed frequently for spraying, nicotine bentonite seems to be the most

useful of the preparations that could be made from tobacco.

For the manufacture of insecticidal and fungicidal compositions the toxic substance is, of course, important. Other materials known as auxiliaries are equally essential for the preparation to be highly effective, economic and safe. Some of these are diluents, spreaders and sticking agents. Gums and resins, clay and cheap oils suitable for soap making come under this category and their availability is discussed in detail in the appropriate sections of this symposium.

FRUITS

BY

MR. J. VEERA RAGHAVAIAH, M.Sc. (HONS.)

(*The India Fruits Ltd., Kadiam.*)

The most important industry of fruits is that of canning and preserving. The aim of canning is to preserve the surplus fruit in the season or a product made out of it so that it is available at other times of the year and in other parts of the country where that particular fruit is not grown. During the process of canning the losses in food value, vitamins and the natural flavour and aroma of the fruit should be the minimum.

As far as this industry is concerned, America is the best developed part of the world, England is ranked second and other European countries come next. England is the largest consumer of canned fruits and vegetables in the world, whereas, America is the largest producer of the same. In England and America a good deal of research is being done on the canning of fruits and vegetables in the Universities of Cambridge, Bristol and California. There are some technical and marketing organisations helping the canneries on the marketing side which is a vital aspect of this new industry, and as a result this industry has been fully standardised in those countries.

In India Canning is a new industrial enterprise. It is growing slowly on a cottage industry scale and there are a few canning factories. They are about half a dozen in number, either in working condition or under

erection, one in the Travancore state, another at Bezwada, a third at Bombay, the fourth at Kadiam (East Godavari District), the fifth at Shazahanpur in U.P. and the sixth in the Punjab.

It is also reported that there is another factory running in the Calcutta City. Regarding the research aspect of this industry, this country is far behind the others. We have "*The Fruit Preservation Laboratory*" in Lyallpur under the Punjab Agricultural Department, "*The Government Fruit Canning Station*" at Quetta and "*The All India Canning Institute*" at Delhi recently started by the Scientific and Industrial Research Board under a scheme of research on canning. The only private firm maintaining a fruit research laboratory in India is "*The India Fruits Ltd.*" at Kadiam, where all the local fruits available in the Andhra parts are dealt with.

Regarding the Andhra Desa, the best fruit area covers the Godavari and Vizagapatam Districts, where various kinds of fruits are extensively grown. In these parts huge quantities of fruits and vegetables either go to waste or are sold at prices which seldom fetch any profit to the cultivators; this is partly due to lack of knowledge in the arts of canning, preserving and cold storage. Canning and preserving undertaken in a systematic way is the best method of utilising the surplus fruits in the season, though mechanical refrigeration both for storage and transport purposes which has so greatly helped the development of the horticulture, fishing, poultry-forming, dairying and the live-stock industries of other countries, may also solve the problem

of purveying of the surplus fruits in these parts. In Palakollu and Narsapur, limes are grown so abundantly that it appears to be a very promising area for the manufacture on a commercial scale, of Citric acid which is one of the materials of the fruit canning industry and which is being imported into India in large quantities. Then we come to the neighbourhood of the Rajahmundry town which is undoubtedly the best centre for a variety of fruits with many transport facilities. In this area mangoes, guavas, sapotas, bitter oranges, Batavian oranges, Indian shaddack (Pamparapanas). bananas and custard apple are grown extensively. Limes may be obtained from Narsapur and Palakollu at a very low cost by Godavari river and indigenous pine-apple varieties from the sorroundings of Vizagapatam and Simhachalam. Special varieties of Pine-apples and Tomatoes could be grown in these parts as the land is fertile and best adopted for the cultivation of fruits in general. A Fruit Industry running on systematic lines could very easily work for at least ten months in a year, as some fruit or other is available all the year round. Pithapuram, Tuni and Anakapalli are also good fruit centres which are mostly known for the best varieties of the Guavas, though mangoes, sapotas and oranges are also available in fairly large quantities. Good varieties of guavas and mangoes are also grown in the surroundings of Bezwada.

All these fruits can be canned or preserved in a variety of ways depending upon the chemical composition and the nature of the characteristic flavour of the particular fruit. Sound and firm ripe mangoes could be canned as slices in sugar syrup and fully ripe ones as

mango pulp, squash or jam. Guava fruits are canned as seedless halves or quarters and Guava Jam could be manufactured as a by-product from the seedy portion scooped out in preparing the halves. From limes lime squash forms the primary product whereas lime jelly could be obtained as a secondary product. The best source for Orange Marmalade and Orange Squash or Cordial is the bitter Orange which is grown very abundantly and sold at low prices in these parts. It also forms the best raw-material for obtaining the Terpeneless Oil of Oranges so widely used in the fruit industry for flavouring purposes and also the fruit pectin and the bitter glucosides of Orange Kernels as secondary products from the waste, the main products being Orange Marmalade and Orange Squash. Sapotas may be preserved as Sapota Juice or Preserve or Jam but sapotas having a delicate flavour which seems to be highly volatile, are not convenient fruits for canning. Kamala oranges can be canned as seedless sections in sugar syrup, and also as Marmalade or as Squash. Batavian Oranges also could be preserved in many of the ways mentioned above. As has been described above in the case of these local fruits the waste could be properly utilised resulting in the manufacture of a good by-product which is of vital importance for any chemical industry to run on economic and profitable lines.

Though fruits form the most important raw-material, this industry has to depend on many others such as Sugar, containers (cans, Jam jars and Squash bottles), fruit acids such as Citric and Tartaric and other chemical preservatives so much used in the preservation

of juices. Regarding Sugar, Andhra area enjoys an advantage in having a good number of sugar factories and refineries so that best grades of sugar are locally available. Unfortunately there is no glass factory worth mentioning in Southern India manufacturing Glasses and bottles and these have to be imported from the North which costs the cannery a good lot. For the manufacture of tins, tin-plates have to be imported from European countries since the tin-plate made in India is of inferior quality and not suitable for fruit canning. With all these minor handicaps, the Andhra Fruit Industry is bound to have a bright future because of the availability of the main raw-material namely fruits, in abundance, in the fresh condition, and at low prices all through the year. An ideal fruit industry is one which grows its own fruits by maintaining orchards, manufactures its own sugar of the required quality, and makes tins from tin-plate and glass containers by running a glass factory. It is quite possible for the Andhra Country to develop the industry on ideal lines provided the Andhra capitalists have the proper industrial enterprise.

Another feature of this industry which is of no less importance is the running of an efficient sales-organisation on the most up-to-date lines and the proper education of the public to consume more canned fruits by way of intensive propaganda and advertisement such as "*Eat more fruits for vitamins.*"

WOOD DISTILLATION AND POWER ALCOHOL

BY

MR. N. V. SUBBA RAO, M.Sc. (HONS.)

(*Andhra University, Waltair.*)

Wood Distillation.

Though the manufacture of charcoal from wood is one of the earliest chemical operations carried out by man, the old methods are very wasteful, as all the valuable distillation products are lost. In modern processes, these products are collected and sold in the crude form or worked up into marketable derivatives. Wood distillation, although not comparable with the distillation of coal, gives rise nevertheless to an extraordinary variety of products (*e.g.*, charcoal, acetic acid, acetone, methyl alcohol, tar containing various medicinally useful products, resin, turpentine etc.) which are essential for various industries. For purposes of distillation, the woods are broadly divided into two categories (1) Hard woods and (2) Soft woods or resinous woods. The former on distillation give rise to larger amounts of acetic acid and alcohol, whereas the latter yield more tar and oils. The methods of distillation, the products obtained and also the refining of these products differ in the two types of woods.

This industry seems to be very suitable to the Andhra area which possesses enormous quantities of wood. Of the numerous kinds of wood that are available, the most important are Sal (Shorea robusta) in the forests North of Godavari, Teak (Tectona grandis) in

the Godavari district, Rosewood (Dalbergia latifolia), Yegisa (Pterocarpus marsupium), Maddi (Terminelia tomentosa) and Sarugudu (Casurina equisetifolia) in the forests of Northern Circars and Sandal-wood (Santalum album) in the Dekkan districts. This area does not seem to contain soft woods in any appreciable quantity as all the above mentioned woods belong to the class of hard woods. Most of these woods, though not obtained from these localities, have been studied by Watson and Co-workers (The distillation of some South Indian woods—Watson, Sudborough *et al.*) and the results obtained by them are tabulated below :—

By wt. per 100 parts undried wood.

Botanical Name.	Moisture.	Total distillate.	Charcoal.	Gas.	Acetic acid.	Methyl alcohol	Tar.
Casurina equisetifolia (old) ...	24.0	50.5	28 0	21.5	3.68	1.15	6.2
,, (young) ...	32.4	55.2	26.2	18.6	2.66	1.13	6 1
Shorea talura ...	18.1	51.9	36.6	11.5	2.94	1.14	6.0
Tectona grandis ...	19.5	54.1	31.3	14.6	2 83	1.35	8.9
Dalbergia latifolia.	16.1	48.0	34.1	17.9	2.53	1 86	11.0
Pterocarpus marsupium ...	26.1	47.3	30.7	22.0	2.40	1.25	5.5
Terminelia tomentosa ...	20.8	43.3	36.1	20.6	2.08	1.05	4.6

The above results relate to laboratory tests and on a commercial scale it was found that the yields of acetic acid were greater by 0·2 – 0·3% whereas methyl alcohol yields were irregular and no conclusion could be drawn.

Though the yields of acetic acid and methyl alcohol from these woods are comparatively less than those

obtained in America, Germany and England (acetic acid from 3·6 to 5·0% and methyl alcohol 1·2 to 1·8%) the Casurina and Teak which nearly approach the foreign woods could be successfully employed for the purposes of distillation. Research is also needed to find suitable ways and means to get these valuable products in better yields from the existing, abundantly available woods by proper treatment with suitable chemicals. The waste wood from the timber industry could also be subjected to distillation in specially designed retorts (Ref: 1. Technology of wood distillation by Klar and 2. Wood distillation by Hawley) and thus add to our resources for the production of the valuable solvents like methyl alcohol and acetone.

A detailed investigation on the available raw materials, the products of their distillation, and the working costs are necessary before anything definitely could be said about the establishment of the industry. There seems to be a great future for this industry in the Andhra area, as it lacks in coal and mineral oil resources and as there is need for a suitable fuel for power purposes. As a result of this industry, not only a concentrated fuel in the form of charcoal but also valuable chemicals like acetic acid, acetone and methyl alcohol are produced, thus giving a very wide scope for the expansion of several other industries dependent upon them.

Power Alcohol.

Every one is aware of the importance and the need for Power alcohol especially at a time as this when the supply of petrol may be limited. Though in general power alcohol means alcohol used for power purposes,

it has come to mean absolute alcohol. This is because of the difficulties encountered in getting homogeneous mixtures of petrol and 96% alcohol when mixed in proportions required for the normal working of the automobiles. As a result of the various experiments conducted in Cuba, Philippines, Queensland etc., it has been found to be advantageous to mix 15 parts of absolute alcohol with 85 parts of petrol, as this blend is reported to give a greater mileage and as it possesses better properties, than simple petrol.

There are several raw materials (such as sweet potatoes, palm juice and jaggery, cane jaggery, molasses and mohua flowers) from which power alcohol can be produced. From whatever source the alcohol may be obtained, it should be available at a price equal to that of petrol. For this purpose the raw material should be very cheap. From the prices prevalent in the Andhra desa, the cost of the raw material required for the production of 1 gallon of absolute alcohol is calculated and given below :—

Raw material.	Its market price.	Cost of the raw material per gallon of absolute alcohol. Rs. A. P.	Remarks.
1. Molasses	4 as. md. (82½ lbs.)	0 1 9	Distillery adjacent to the factory.
,,	(Ry. freight 4 as. 3 ps. per maund).	0 3 9	Central distillery.
2. Mohua flowers	Rs.1-8-0/md.	0 12 0	
3. Palm juice	1½ as-/ pot of 4 gals.	0 5 0	
4 Palm jaggery	Rs. 5/md.	1 4 0	
5. Cane jaggery	Rs. 3/md (beginning of the season)	0 12 0	
6. Sweet potatoes	9 pies / viss of 3 lbs.	1 4 0	
7. Cane tops	...	...	Expected to be low in the vicinity of the sugar factories.
8. Low quality cane	...	...	

From the above data it is clear that molasses is the only raw material which is cheap and available in a considerable amount. No doubt, if the distillery were located near a sugar factory, this raw material can be easily supplemented with cane tops and low quality canes which should be available very cheap.

Molasses is one of the byproducts of the sugar industry and due to the absence of any outlet for this material, its disposal has become a problem. Even those factories which export their molasses to the United Kingdom do not get more than 1 anna 2 pies per maund (82⅔ lbs.) The following table indicates the amount of molasses produced at present by each Sugar Factory in the Andhra area and their maximum possible output.

District.	Location of the factory.	Molasses produced at present (tons) per annum.	Max amount of molasses capable of production (tons).
Vizag	Sitanagaram	...	1,400
	Bobbili	650	650
	Thummapala	190	600
	Etikoppaka	200	300
Godavari	Samalkota	3,800	3,800
	Kirlampudi	320	600
Kistna	Vuyyur	1,200	2,400
Bellary	Hospet	1,800	2,100
	Total	8,160	11,850

Hence the total amount of molasses available at present in the Andhra area is about 8,000 tons annually and from this 4,80,000 gallons of absolute alcohol (60 gallons per ton of molasses) can be produced. When the factories reach their maximum output, it is expected that there will be a production of 12,000 tons of molasses per annum which can yield 7,20,000 gallons of alcohol.

The next to be considered is the amount of alcohol actually required in this area for blending with petrol in the above mentioned proportion (15%). The total annual consumption of petrol in the Madras Presidency (1938–39 figures) is about 14 million gallons out of which the Madras city alone consumes 4 millions and the Andhra districts 3 million gallons. Calculating at 15%, the amount of alcohol required for the Andhra districts is 4,50,000 gallons and for Madras 6,00,000 gallons. Therefore the amount of alcohol that can be produced now is just sufficient for this area and in future when the production rises to 7,20,000 gallons, the excess (roughly about 3,00,000 gallons) may be supplied to the Madras city or may meet the increasing demands for petrol in the Andhra area itself. In any case, there is no trouble as regards the utilization of the alcohol produced.

Anhydrous alcohol is produced on a large scale adopting one of the following methods: (1) Azeotropic methods, (2) Salt dehydration methods. Of the two, the former with the recent improvements (Melle's fourth technique) seems to be better as far as the distilleries having a daily capacity of 1,000 gallons and above are concerned and for smaller ones, the gypsum method, one of the salt dehydration methods could be adopted. The cost of production of a gallon of absolute alcohol (working on the Melle's process) ranges from As. 6 to 7 and the details are given below:—

Estimated cost of production of 1 gallon of absolute alcohol.

Number of working days ...	150
Daily production	1,000 gallons.

Total alcohol production per annum.	1,50,000 gallons.
Molasses required	2,500 tons.
Method of manufacture ...	Melle's fourth technique.
Cost of installation delivered, erected and put into operation, including building and royalty etc. ...	Rs. 1,90,000

Details of cost of production.

1.	Molasses at Rs. 7/ ton ...	17,500
2.	Cost of fuel (35 lbs. of steam/ gallon of alcohol or 5 lbs. of coal/ gallon of alcohol . ...coal required = 335 tons at Rs. 12/ ton	4,020
3.	Sulphuric acid 2,275 gals. at Rs. 2½ a gallon	5,600
4.	Ammonium sulphate 2½ tons at Rs. 12 a ton	300
5.	Dehydration liquid 70 gallons benzene at Rs. 8 per gallon ...	560
6.	Labour, supervision etc. ...	6,000
7.	Light, power, lubricants, upkeep, repairs etc.	800
8.	Insurance, Fire, workers compensation etc.	800
9.	Depreciation— at 10 per cent on plant and Royalty 1,40,000 ...	14,000
	at 5 per cent on building 50,000	250
10.	Interest at 6 per cent on 1,90,000	11,400
	Total ...	63,480

Cost per gallon of alcohol

$$= \text{As.} = \frac{63{,}480 \times 16}{1{,}50{,}000} = 0\text{-}6\text{-}9$$

It is better to entrust the management of the distilleries and the supply of alcohol to the sugar factory owners. From the amounts of molasses available, it seems to be advantageous to locate four distilleries in the Andhra area (1) at Hospet, (2) at Vuyyur, (3) at Samalkota and (4) at Bobbili or Sitanagaram. Further, only the costlier raw materials like mohua flowers should be employed for arrack production leaving behind the cheap raw material molasses for power alcohol production. With the location of distilleries as given above it is quite convenient to distribute the alcohol to the different petrol consuming centres in the area.

As has been mentioned already, to make the scheme work successfully, the alcohol mixed with petrol should also be available at a price at which the petrol is sold. Further, a duty on alcohol equal to that of the import duty on petrol (As. 10/ gal.) should be paid so as not to affect the revenues of the Government of India. That means the alcohol for such purposes should be available at a price equal to the selling price of petrol minus import duty *i.e.* Normal rates (Prewar): Inland 1–5–0 minus 0–10–0 = 11 As. gal. and at ports 1–1–0 minus 0–10–0 = 7 As. gal. The cost of production data reveals that it is quite feasible to produce power alcohol at these prices starting with molasses as the raw material and locating the distilleries at the above mentioned centres.

DYES AND TANS

BY

DR. P. SURYAPRAKASA RAO, M. Sc. (HONS.), PH. D.

(*Andhra University, Waltair.*)

It is well-known that the technical value of the natural dyestuffs has greatly decreased in recent years, and this is on account of the production of synthetic dyes at a cheaper rate. Though the synthetic dyes have replaced the natural ones in a majority of cases, there are still, some others, notably logwood, fustic, Persian berries and catechu that find extensive use even to-day.

Under normal conditions it would be difficult to replace the synthetic dyes by natural ones, since the former happen to be cheaper and more easily available. However during times of war, the situation is different. There is a growing scarcity of every foreign product, and wherever the stuff is available, it is sold at very high rates. Consequently our textile and dyeing industry is sure to go out of gear, unless proper steps are taken to avert the crisis.

Hundreds of years before the advent of the synthetic dyes, India used to produce the finest fabrics in the world, dyed with beautiful fast and variegated shades and these dyestuffs were obtained from natural sources. Luckily India still abounds in such natural materials. However our knowledge of the usage of these is gradually dying out. It is the aim of this paper to make a study of the possibilities of reviving our old dyeing industry with special reference to Andhra Desa. The

time is now very propitious for doing so, since the war has considerably reduced the imports. It should, however, be borne in mind that the industry, when once started, must not disappear with the reappearance of the synthetic dyes after the close of the war but should be so organised as to be in a position to compete with the foreign products. Such of the natural dyes that can be economically worked are chosen for consideration, and an account of the methods of their utilisation is given in the following pages. It is hoped that these, if properly harnessed, organised and controlled, can amply satisfy the needs of the country.

Many tan-yielding plants and trees grow abundantly in the Andhra Districts. Since tans are closely associated with dyes and are frequently used as mordants, they are also included here. The Telugu equivalents of the botanical names of the various plants and trees are given within brackets.

DYES

Butea frondosa

(Moduga)

It is a moderate-sized deciduous tree found throughout India and is plentiful in the forests of the Circars. The flowers of this tree yield a brilliant yellow dye, much used during the Holi festival. This is extracted either by expressing the sap of the fresh flowers or as a decoction or infusion from the dried ones. However the shades produced are only fleeting. On the other hand a more permanent result is produced either by first preparing the cloth with mordants like alum, lime or woodash or by adding these substances to the dye-bath.

In combination with Terminalia chebula, the same effect is produced since the tannins present therein serve the purpose of mordants. When combined with indigo, shades of green and light blue are formed.

Bixa Orellana

(Jafara)

It is a graceful shrub with handsome white or pinkish flowers. It is much valued for the red or the orange dye obtained from the pulp that surrounds the seeds. To prepare the dyestuff, the seeds and pulp are removed from the mature fruit, macerated with water and the mixture allowed to ferment. The product is strained through a sieve and the colouring matter which settles down is collected, partially dried by heat, then placed in boxes and finally dried in sun. The dyestuff thus prepared is called Annato. If fermentation is avoided in the above process, the product is known as Bixin. Bixin is said to be five to six times more valuable than Annato.

The dye is largely used for dyeing silks. It can also be used for colouring even edible articles like cheese and chocolate. The beautiful flesh colour characteristic of the dye is altered by certain combinations into orange or even red, for example, in combination with Kamala. For dyeing silks the bath is made up with equal parts of Annato and sodium carbonate; soap is also usually added and the dyeing is continued at 50° for about an hour according to the shades required.

Wool is dyed at 80—100° without any addition to the bath.

In the case of cotton the Annato is first dissolved in a boiling solution of sodium carbonate and the goods are then entered into the bath and left for quarter of an hour. They are subsequently pressed out and washed with alum solution.

The shades, though slightly fugitive to light resist the action of soap and dilute acids very well.

Curcuma longa—Turmeric.

(Pasupu).

The plant is extensively cultivated in the Andhra area. The yellow colouring matter called curcumin is present in the rhizomes. It changes to almost red with alkalis. Alum is said to purify the colour by destroying all shades of red. The dyers of Calcutta produce a brilliant yellow called Basant Rang by mixing the turmeric with Sajimati (carbonate of soda) and lemon or lime juice. The acid is apparently used to correct the red tint produced when the alkali acts on turmeric.

The tinctorial properties of curcumin are of special interest, for not only is it a strong colouring matter but also a substantive dye. To wool and silk a boiling solution of the colouring matter imparts an attractive yellow colour. For cotton, however, the dye-bath is usually rendered slightly acidic with acetic acid or alum. Mordants intensify the shades produced on wool or silk.

It should be noted, however, that the shades are neither very permanent nor fast to light or alkalis. Nevertheless, turmeric can be advantageously used in compound colours. If the fabric is first dyed with indigo and then dipped into a decoction of turmeric, green

shades are produced, and in conjunction with butea flowers fast yellow shades are obtained.

Turmeric finds an extensive application in calico-printing. A mixture of pomegranate rind (2 lbs.), turmeric (5 lbs.) and alum (1¼ lbs.) is treated with water (4 gallons) and left to stand overnight. The surface water is then strained off and indigo (½ lb.) is added. The mixture is then prepared for use by thickening with gum, butter and flour. The colour imparted is greenish yellow.

Morinda tinctoria.

(Thogaru).

The tree is found throughout India and is abundant in the Circars. The roots of Morinda tinctoria and Morinda Citrifolia (Maddi) are extensively employed in various parts of India under the trade name of Suranji used for dyeing reds, purples and chocolates. The colouring matter is chiefly found in the root bark and is developed in maximum yields when the tree is three years old. The tint seems to depend primarily upon the age of the root. The root-bark gives the best reds; the dye in the woody part of the root is yellow, and depending upon the relative proportions of the bark and the wood, the tints vary from red to yellow.

For the material to be used as a dye, it is necessary to remove the free acid present in considerable quantity in the root. For this purpose 1% of chalk is to be added to the dye-bath. Wool and silk can be dyed without mordants to rich orange or yellow colours. But with mordants (Cr, Al, Sn and Fe) the shades change to rich chocolate, orange-red, bright orange or even purple.

On oil-prepared calico very fast and bright tints like orange-red, scarlet, chocolate, purple or even black are produced, depending on the nature of the mordant.

Mallotus phillippinensis.

(Vasantagunda chettu).

It is a small ever-green tree found throughout tropical India and is fairly abundant in the Andhra Districts. Kamala is the powdery substance obtained from the exterior of the fruits. It is known in Telugu as Kunkuma, Kapila, Vasantagunda, Chandrachinduram etc. It can be used for dyeing silk and wool a bright orange colour of very great beauty. The bath contains 4 parts of Kamala, 1 part of alum and 2 of sodium carbonate. The mixture is rubbed well with a very small quantity of sesamum oil. It is then put into boiling water and the fabric to be dyed is boiled in the bath smartly for more or less time according to the shades required.

Oldenlandia umbellata.

(Cheriveru).

The plant is a small bush found on sandy soils near the sea coast. It is most abundant on the coastal tracts of Andhra Desa, especially near Masulipatam and Nellore. The roots of this plant form a very valuable dye and are marketed under the trade name of Chay Root.

The colouring matter is present chiefly in the bark of the roots. The dye produced therefrom is very fast, and was formerly employed in Madras for dyeing the "Bandanas" for which that town was once famous. Although the root contains acid principles which tend to

dissolve the mordants, its employment as a dye offers no difficulty. The only precautions necessary to be observed are to add 2% of chalk to the dye-bath and to raise the temperature gradually to the boiling point. The essential process in dyeing is to boil the mordanted fabric with the powder of chay-root and chalk. Wool, silk and cotton can be dyed with beautiful fast colours. Good brown, red, orange, purple, pink, chocolate and lilac shades are produced, depending on the nature of the mordant used.

Pterocarpus santalinus.

(Kuchandanam, Raktachandanam, Lalachandanam, Erragandham etc).

It is a small tree of South India, chiefly found in Cuddapah and Kurnool districts. The wood contains a red colouring matter called "santalin" which is easily extracted by any alkaline solution. The fabric is merely boiled with the powdered wood and carbonate, and the tint produced is said to be permanent. The wood is also used for culinary purposes.

TANS

Acacia arabica.

(Thumma)

The tree grows plentifully all over India except in the most humid regions. In Andhra Desa it is cultivated near villages and on waste lands, especially on black soil. The bark is a powerful astringent and is largely used by the tanners. An infusion or a decoction of the bark imparts a buff colour to the leather. The pods are also used as a tan.

Cassia auriculata.

(Thangedu)

It is a shrubby plant growing abundantly in Central and South India. The bark of this plant is one of the most valuable of the Indian tans, yielding a buff colour to the leather.

Caesalpinia coriaria.

(Divi-divi)

Though not a native of India, the tree has acclimatised itself to the conditions of South India and grows fairly abundantly in the Andhra Districts. The pods of the tree contain the important tanning material. The seeds are removed before the pods are extracted with water, as otherwise an injurious fermentation sets in and discolours the skin.

Terminalia chebula.

(Karakkayala Chettu)

It is a large deciduous tree abundant in North India and the Deccan table-land. It is found extensively all over the forests of Andhra Desa. The dried fruit of this tree forms the "Chebulic" of "black" myrobalans of commerce, and is one of the most valuable of the Indian tanning materials, imparting a bright brown colour to the leather. The liquor from the rind is not merely a tan but also a dye for cotton, wool and silk. The cloth steeped in this infusion acquires a dirty grey colour. With alum as mordant a good permanent yellow is produced. But its most extensive use is in the production of black in combination with iron salts. Depending on the amount of the

mordant used, even beautiful khaki shades are formed. It gives green shades in company with turmeric, dark blue tints with indigo and brown ones with catechu. Besides the fruits, the bark of the tree can be similarly used for dyeing khaki, grey and black shades.

REFERENCES.

1. "Dictionary of the Economic Products of India" by Watt.

2. "Natural Organic Colouring Matters" by Perkin and Everest.

PAPER

BY

MR. P. BHASKARARAMA MURTY, M.Sc. (HONS.)

(*Andhra University, Waltair.*)

The raw materials for the production of pulp or cellulose are generally obtained from three sources in any particular area (1) Wood from Forests (2) Agricultural byproducts (3) Rags and waste paper. Suitable woods are obtained from the forests for cellulose production and by systematic aforestation projects this supply is made continuous. But in India no suitable woods for the production of pulp are yet found out. Of the forest produce next in importance to wood, are the bamboo and certain varieties of grasses which are successfully pulped in India.

The Andhra area comprises vast tracts of forests (nearly 7 lakhs acres) distributed all over the districts and bamboo can be obtained in considerable amounts. For its successful exploitation there should be means of easy transport and continuity in its production and supply. These considerations were found favourable and the Andhra Paper Mills Co., was started at Rajahmundry to utilise the bamboo from the agency and one paper machine is working there. The agency tracts in Vizagapatam district can also be tapped. However, it should be noted here that bamboo pulp is mostly used in India to supplement the major bulk of the imported wood pulp. Regarding the grasses, certain varieties of

them, lantana and marul grasses grown in Kurnool and Cuddapah districts can be utilised on a small scale.

The agricultural byproducts constitute an important source of raw material in this area. Nearly 17 million acres are sown in the Andhra districts with various annual crops. The sugarcane bagasse, straws, hemp and other wastes can be properly utilised for the production of the pulp. Bagasse is mostly used in the sugar mills for fuel and this will continue to be so since no cheap power resources are found in the Andhra area. The straws, mostly rice straw can be utilised to produce good writing paper with sufficient hardness and rattle which are not found in the paper made from bamboo. Further the supply of raw material will be continuous since it is an annual crop and is not a high class fodder. We found out in these laboratories that most of the varieties grown in these districts contain 37—40% of cross and Bevan cellulose. But the pulping of the straws offer certain difficulties and we have studied various processes in detail and found out a suitable method. This requires no complicated and expensive equipment and can be successfully employed to utilise the annual crops. By this process, 42% of pulp on the weight of the straw can be obtained. It bleaches well and contains about 80% of α-cellulose. The utilisation of these straws is necessary since bamboo supplements other imported pulp to 30—35% only. Next in importance to rice straw are the ragi and cholam straws. Ragi straw is found to have nearly the same characteristics and pulp yields as rice straw but the cholam straw contains nearly 65% of α-cellulose. However, it is a good fodder and its availability is limited.

Besides straws there are other fibre yielding crops like sunhemp, rosellehemp (Hibiscus sabdariffa) and jute. The fibres are locally employed for special purposes but if cultivated on a large scale can be employed as raw materials for certain cellulose industries. They contain high percentage of α-cellulose. Rosellehemp contains 80—85% of α-cellulose. At present they are not available for paper making.

With the supply of cheap electric power to the rice mills the disposal of rice husks will be an immediate problem. The husks contain about 42% crude fibre and can be used as filler in the paper production.

The rags and the waste paper are perennial sources for the production of pulp. From the rags we obtain very high class cellulose so essential for good quality paper. This source should be profitably exploited to supplement the pulp from the annual crops. Waste papers can be processed by many modern methods and supplemented by virgin fibres. Unfortunately the collection of these valuable materials is completely neglected even in our larger towns.

Thus the potentialities for pulp and cellulose production seem to be promising and by suitable methods and organisation the annual crops should be exploited in any scheme to be worked in these parts. Modern trends in these industries recognise the necessity of using the annual crops. South Africa, Argentina, Italy, Germany and Japan employ these raw materials profitably for their cellulose industries and this seems to be the only convenient source where there is no indigenous wood pulp.

The sources of important auxiliary materials for the production of paper are abundant in these parts. Mostly in the Vizagapatam district and to some extent in the Godavary district large deposits bearing China clay are present. They yield on an average twenty per cent of China clay and the exploitation of these resources will greatly help the paper industry. Besides this Ochres and other minerals useful for finishing purposes can also be obtained locally since they are widely distributed. Other auxiliaries like resin and glue are mainly obtained from the forests. In this area there are vast tracts of forests which yield valuable minor products. Thus auxiliaries of both mineral and forest origin are available in sufficient amounts to meet the demands of the industry.

The straws or other annual crops like sugarcane bagasse have been experimented upon in these laboratories for the production of viscose films. The straws contain about 32—34% of α-cellulose and the bagasse about 45—50%. The raw materials are processed by acids and the resulting cellulose is employed for the preparation of the soda cellulose and the xanthate. They yield finished products which are quite satisfactory and further details in this direction are under investigation.

OILS

BY

MR. C. J. DASA RAO, B.Sc. (AG.), M.Sc. (HONS.)

(Andhra University, Waltair)

The large group of natural products called oils *i.e.*, fatty oils may be divided into two categories (1) the drying and (2) the non-drying. The well-known examples of the former class are the Linseed, Tung oil etc. and of the latter class the groundnut, cotton seed, cocoanut, gingelly etc. The drying oils are essential for the paint and varnish industries and they are very little used in other industries. The non-drying oils form the raw material for a number of industries. The most important use of these oils is for edible purposes and the next in importance is the production of soaps, in which glycerine is obtained as a byproduct. Besides these some oils, *e.g.*, Codliver, Shark liver, Chaulmoorga and Castor are specially useful therapeutically whereas some of them *e.g.*, castor are employed as lubricants. To a small extent they are also used for fuel and lighting purposes.

India stands second in the world among the oil producing countries. The area under oil seeds in India is about 32 million acres out of a total of about 267 million acres of cultivated land. The Madras Presidency stands first with regard to the production of oil seeds and it has about 8 million acres of land under cultivation growing this raw material. Of this more than half comes from the Andhra districts. The area in acres of the principal oil seeds produced in each district is tabulated below :

Name of District	Linseed	Gingelly	Mustard	Ground nut	Cocoanut	Castor	Other oil seeds	Cotton	Total area in each district
Anantapur ...	...	29,100	4	4,46,500	484	69,300	13,600	1,07,100	6,66,088
Bellary ...	2,027	11,600	96	4,16,600	1,704	15,900	16,900	5,69,000	10,34,127
Cuddapah ..	212	3,100	...	2,29,500	117	8,600	3,600	38,700	2,83,829
Kurnool ...	617	2,500	67	4,80,100	20	31,400	38,600	1,77,600	7,30,904
Nellore ..	139	3,500	...	16,600	283	47,600	32	34,700	1,02,854
Kistna ...	...	7,800	45	1,09,300	1,207	8,700	...	17,600	1,44,652
Guntur ...	2	1,000	97	3,52,900	183	31,900	321	73,400	4,59,803
East Godavari ...	...	89,300	148	158	52,600	7,900	...	7,100	1,57,206
West Godavari ...	194	69,200	...	6,454	9,950	6,400	...	759	92,957
Vizagapatam ...	...	1,42,800	7,022	1,26,300	2,340	10,200	80,100	13,600	3,82,362
Total area under each crop in acres.	3,191	3,59,900	7,479	21,84,412	68,888	2,37,900	1,53,153	10,39,859	40,54,782

It is clear from the above table that the Ceded districts contribute the maximum share and Bellary stands first. The districts of Guntur and Vizagapatam come next in importance. In any scheme for the location of the industries depending upon this raw material this data has to be taken into consideration. Further the data indicates that the locality is very rich as regards the non-drying oils and an appreciable quantity of drying oil, Linseed, is produced only in the Bellary district. Therefore there is great scope for the starting of the oil refining, vegetable butter industry and soap manufacture. In addition to the industries dependent on the vegetable oils, the Andhra area which has a long stretch of coast line seems to have great potentialities for the extraction and refining of fish oils. Though at present no definite statistics are available regarding their quantity and quality it is quite possible in future to start this industry at one or two centres along the coast line. The amount of the principal oil seeds available in each locality and to which type of industrial use they can be put with advantage will be considered next.

Among the oil seeds groundnut stands first both in area and importance. Nearly 1 million tons of seeds are produced in this area. The oil content of the undecorticated seeds is about 35% on the weight of the seed. About half of the crop is exported to foreign countries mostly in the form of decorticated seeds. Due to this export of the seeds we are not only exporting the raw material at a cheap rate and importing back the costly finished products but also losing the valuable

cake which is very useful both as cattle food and as a manure. Our Agriculture would have been in a better condition had this cake been retained in this country. When properly refined, the groundnut oil forms one of the best edible oils. It is strange that refined oil to the extent of about 8,040 tons per year is imported into this area from other parts of India. This large import can be stopped by establishing oil refining industry in this area and we can export to other countries oil instead of seeds and thus retain the valuable cake. Two centres namely Anantapur and Bellary in the Ceded districts and Guntur and Vizagapatam in the coastal part can be selected for locating this refining industry. In addition to groundnut other oils like gingelly and castor can also be refined. For every 110 tons of oil there is obtained about 100 tons of refined oil, and the alkali residue can be used for soap making. By starting oil crushing industry a large supply of cake and also husk will be made available for local use. In addition to oil refining at Vizagapatam vegetable butter can also be manufactured in view of the prospect of electrical energy being available at a very cheap rate for the production of hydrogen. Groundnut oil has the highest calorific value of 4,075 calories per lb. compared to cocoanut oil 4,050, ghee 3,900 and sugar 1,860. Thus this oil is particularly rich and an industry to utilise this oil for making edible products is essential in this area.

Next in importance is gingelly. The seed is produced to the extent of about 45,000 tons. The oil content is about 50 to 57% on the weight of the seed; Vizagapatam and Godavari districts are the largest

producing centres. The oil is largely consumed for edible purposes. A small quantity is exported to other countries where it is refined and used as an adulterant with olive oil. The oil can be used in the soap industry, but because of the high cost it can only be refined for edible and for toilet purposes.

Cotton seed is another important oil seed which is available in very large quantities in Ceded districts and Guntur. The amount of seed is estimated at about one million tons. Though the oil is not extracted in these parts, in America the oil is very largely used after refining in the edible oil industry. In the two centres suggested in the Ceded districts the oil can be refined and in addition it can be used for the manufacture of soaps. It is found that nearly 6,020 tons of household soap and 1,216 tons of toilet soap is being imported into these parts. One ton of oil gives roughly 2 tons of soap. Hence a soap factory at Bellary in addition to the refinery can use up a good quantity of cotton and groundnut oil for soap making. The glycerine which will be produced as a byproduct in the soap industry will roughly work out at 10% on the oil used. This can be recovered and made into crude glycerine.

Godavari district is the only place where atmost the whole of the cocoanut is produced. Next comes Vizagapatam. The oil is very good for refining, and making vegetable butter and toilet preparations. It can also be used for making cold process soaps. As Vizagapatam has already been suggested as a centre for starting a refinery, the cocoanut oil can be used up by that factory.

Castor oil is used locally as a medicinal oil and also for burning purposes. A large quantity of the seeds is exported to America where it is solvent extracted because of its high oil content. About 20,000 tons of seeds are produced in this area. The oil content is about 45 to 53% on the weight of the seeds. The oil is largely used in lubricating aeroplane engines. It is also used in medicine, leather manufacture, Turkey red oil in textile colouring and in preparing transparent soaps. Again the Ceded districts grow the largest area under this crop, Nellore and Guntur coming next. Castor oil can be refined and used as a hair oil. The cake can be used as a manure. The soap factory suggested at Bellary can consume a good quantity of castor oil in addition to other available oils.

In addition to the above varieties of oil seeds there are a few other oil seeds like the neem, pongamia, Niger etc., which all come under the class of other oil seeds. These oil seeds can be used to a large extent in soap industry. Vizagapatam district has a large area growing other oil seed crops. A soap factory can be started at Vizagapatam to make use of all cheap oils available in the district. Further neem and pongamia oil can be used for treating certain ailments.

So far the amount of non-drying oils available in the Andhra area and their industrial utilization have been considered. As regards the drying oils the area under Linseed is very small and it is found that the seeds are exported to other parts of India. Oil required for the paint and varnish industries in the Andhra area is imported from outside to the extent of about

five lakhs of gallons. In addition to its use as a drying oil, it is also used to a small extent for veterinary purposes. As the quantity of oil produced in this area is very small, investigations into the possibilities of finding substitutes for linseed oil may be useful. Tobacco seed oil is considered to have some drying properties and if the drying power can be improved by the use of dryers or admixture with linseed oil, then the problem of drying oils for the Andhra area can be solved. Guntur is the only district in the presidency which produces nearly 10,000 tons of seeds or nearly 2,500 tons of oil which can be profitably used in the paint and varnish industry, if found suitable.

Thus it is clearly shown that the Andhra desa has large quantities of non-drying oils which can be profitably utilised for starting four oil refining plants at Anantapur, Bellary, Guntur and Vizagapatam and two soap making plants at Bellary and Vizagapatam. As regards the drying oil industry, Guntur may be suggested as a possible centre if Tobacco seed oil can be made a good drying oil by suitable admixture with dryers and limited quantities of linseed oil. It is rather a pity that in spite of all these natural resources the valuable industries have not been started in this area so far.

GUMS, WAXES AND RESINS

BY

DR. S. RANGASWAMI, M.A., PH. D., A.I.C.

(*Andhra University, Waltair.*)

Gums, waxes and resins are complex substances containing carbon, hydrogen and oxygen only and they have the common characteristic that they are non-crystalline in appearance. Gums are elaborated by the plant kingdom only whereas waxes and resins can be of either plant or animal origin. In addition to the above there are the synthetic resins. The gums which are chemically related to the sugars have the property of dissolving in water with more or less ease to form viscous solutions. When in the dry and solid state they are hard and break with a glassy fracture. The waxes are soft and granular at the ordinary temperature and when warmed they soften and become more plastic; with further rise of temperature they melt to form thick liquids. They are insoluble in water and dissolve only in certain organic solvents. They are related to the fats being composed mainly of fatty acids and monohydric alcohols of high molecular weight and their esters. With regard to the resins it is rather difficult at present to classify them under different heads since until recently the tendency has been to call everything a resin which possessed certain physical properties and whose chemistry could not be easily unravelled. They are insoluble in water but dissolve in organic solvents to varying degrees. Some of them are fairly resistant to

the action of acids and alkalies at the ordinary temperature and are thus well suited for use as protective material. Gums and waxes find considerable use in pharmacy and in various trades and industries like wood-polishing, the cosmetic industry and the textile industry. In the following paragraphs a typical gum, a typical wax and a typical resin produced in Andhra are described. Shellac which is economically the most important resin from an All-India point of view is only briefly referred to here, since it is a subject of special study by the Lac Research Institute of Ranchi.

Acacia Gum.

Acacia Arabica (N. O. Leguminosae) is an erect shrub or tree with straight spines, found all over India. In Andhra it grows wild in the upper Godavari tracts and in the Kistna district. It prefers a dry to a moist soil and flourishes in dry arid plains where other trees grow only with difficulty.

The tree yields considerable quantities of a transparent gum which flows out from incisions or fissures in the bark and hardens in lumps called 'tears' of various sizes and shapes. The gum flows out chiefly in March, each tree yielding about two pounds. A few colourless samples obtained from Masulipatam and the neighbourhood and examined in these laboratories were found to pass the tests for purity prescribed by the British Pharmacopoeia for Gum Acacia (an officially recognised gum sometimes also called gum arabic, obtainable from Acacia Senegal); further a solution in water yielded a mucilage which had a greater viscosity than a mucilage of Gum Acacia of equivalent strength. Thus the gum from

A. Arabica seems to be a better emulsifying agent than that from A. Senegal.

At present the Indian gums are little exported to Europe but they constitute an important article of internal trade. The gum from A. Arabica is largely used in India by the calico printer and as an indifferent substitute for gum arabic. In times of scarcity it also constitutes an important article of food. The chief objection to its use in pharmacy is its colour. This depends on a number of factors and with proper care in the collection and subsequent grading it is easy to get the finer colourless variety and the cruder variety separately. The finer gum can be used in pharmacy in the preparation of emulsions and pills and as a constituent of emollient medicines while the commoner grades can be used as adhesive agents in the finishing of cloth, in calico printing and in the preparation of inks, water colours and varnishes. The unpicked variety costs about two annas a pound. Other products obtainable from A. Arabica are the timber which is very hard and durable, the pods which are used for tanning and dyeing purposes and the bark which is a good tanning material.

Bees-Wax.

Bees-wax is the material that constitutes the cell wall of the honey comb and is the voluntary secretion of the working bee. The European variety is chiefly the product of Apis Mellifica while the Indian bees-wax is produced mostly by A. Dorsata and A. Indica and to a smaller extent by A. Florea. The Vizagapatam Agencies are the source of a considerable quantity of bees-wax which formed a significant proportion of the Indian

exports in the past. Here the crude material is purified by repeatedly melting over water and straining. The final product of which a few representative samples have been examined in these laboratories, is remarkably uniform in its physical and chemical properties, though its acid value and ester value do not conform to the British Pharmacopoeial standards. It may be mentioned here that as a rule Indian bees-wax has chemical constants falling entirely outside the B. P. limits. These limits are based on the analyses of the wax from A. Mellifica whose chemical composition is very different from that of the wax produced by A. Dorsata and A. Indica. Hence judged by the B. P. standards even genuine samples of Indian bees-wax would appear to be not of the required quality and would be considered as unsatisfactory for making pharmacopoeial preparations. Since however the wax of the Indian bee is quite good and suitable for all pharmaceutical purposes attempts should be made to popularise its use in pharmacy so that it may find a better market than at present. It is to be hoped that the special characteristics of the Indian wax will be duly recognised by responsible bodies or at any rate by our future national pharmacopoeial commission and the standards for "cera (bees-wax)" so fixed that the country's genuine product is not disqualified.

The chief uses of the Indian Wax at present are in wood-polishing, leather-dressing and in the cosmetic industry in the preparation of wax pomades and cold creams. It is also used to a small extent by gold and silversmiths and in brass foundries for giving finish to moulds. Formerly large quantities were used in

candle-making but it has now been almost completely replaced by spermaceti and other cheaper waxes.

The main lines of improvement that can be suggested for the Agency wax are (1) recovery of wax from the residues left in the purification process and (2) bleaching of the yellow bees-wax to produce the white variety. The recovery of the wax can be effected through the use of solvents like carbon tetrachloride and the recovered product can be used for certain rough purposes. White bees-wax has not only a special use in pharmacy in the preparation of certain ointments and plasters but fetches a higher price in the world market than the coloured variety; the latter costs about half a rupee per pound. The colouring matter of the Agency wax seems to consist mostly of carotene. Experiments carried out with a view to determine the best method of bleaching it indicate that physical methods like treatment with activated carbon and adsorption on Fuller's earth are better suited than more drastic forms of chemical treatment like oxidation with chromic acid which seem to be neither necessary nor desirable. The physical methods leave most of the properties of the wax unaffected whereas the chemical methods raise the melting point and the acid value and lower the iodine value besides rendering the sample somewhat brittle.

Sal Resin and Shellac.

The Agency forests of Andhra abound in the valuable timber-yielding tree, the Sal (Shorea Robusta). When the mature tree is tapped by cutting strips of bark from the trunk it exudes large quantities of a resin

called Sal resin which is whitish at first but becomes brown when dry. The stripping is generally carried out in the month of July. In about twelve days the grooves fill up with resin which is gathered and the grooves are left to fill again. They give three yields which in the best trees may amount to as much as ten lbs. The first is the best in quality. A second collection in October and a third in January are also made from the same wounds but small in quantity and inferior in quality. The resin is usually sold in small rough pieces, nearly opaque and very brittle. The exudation has little taste or smell.

The resin is not known to be exported to foreign countries to any large degree but is used internally for various purposes. It gives out thick volumes of fragrant smoke when thrown over fire and is therefore largely used as a cheap substitute for gum benzoin for fumigating rooms. It is easily fusible and hence is used by boat builders instead of dammar for caulking boats and to plug holes in earthen and metal vessels. It can also be used as a substitute for pitch. It is regarded by native physicians as astringent and is reported to be of use in dysentery, weak digestion and gonorrhoea. The resin is moderately soluble in alcohol, almost entirely so in ether and perfectly in oil of turpentine and the fixed oils. Hence its largest use will be in the manufacture of varnishes particularly when protection of materials is of primary and decoration only of secondary importance. Only a small proportion is consumed for this purpose at present but as a result of intensive research it should be possible to increase the demand for this commodity by the varnish trade.

In addition to the above vegetable resin a considerable amount of the insect-resin shellac is obtained in the Jeypore forests. The practice here till recently seems to have been to send it after preliminary purification to some of the big factories in Calcutta for utilisation in various trades. Recently a small factory has been erected at Jeypore and it is probable that a small lac industry will soon be flourishing there. This industry will have one great advantage compared to many others connected with Indian raw materials. A large amount of research work on lac is being vigorously pursued both at Ranchi and in London under the auspices of powerful commercial combines and as things stand at present there is no danger of Indian shellac being crowded out of the market by synthetic resins.

PAINT AND VARNISH MATERIALS OF ANDHRA DESA

BY

MR. C. VENKATA RAO, M.Sc., D.I.C.

(*Andhra University, Waltair.*)

1. Introductory.

It is a common observation that materials like iron and timber decay in course of time due to weathering *i.e.*, due to exposure to temperature changes, sun-shine and humidity alterations. Iron and timber being the most important structural materials, it becomes imperative to protect these by suitable means. This is sought to be effected by the class of substances called 'Paints and Varnishes'. Besides being protective they decorate the surfaces to which they are applied. As a result of their application, the maintenance and repair costs of huge ocean liners, aeroplanes and luxurious saloon cars have been considerably reduced. Further their application has helped to a large measure in reducing the overhead charges in chemical industries, thus bringing to the door of the common man many articles of consumption which were within the reach of only the well-to-do people. India at present consumes about Rs. 2·0 crores worth of Paint and Varnish materials every year. The import figures given below indicate the present unfortunate position of India.

Imports into India in lakhs of Rupees.

Year.	28–29	29–30	30–31	31–32	32–33	33–34	34–35
Paints and Painter's materials.	89	147	112	88	92	92	97

Indian resources of raw materials are not inferior to those of many countries in which Paints and Varnishes are made on a large scale. Instead they are greatly superior. Mineral deposits of pigment producing metals such as zinc, chromium, antimony, lead, titanium etc., occur abundantly. India has an enviable position in world supplies of linseed oil and lac. Besides it possesses adequate deposits of natural pigment colours. Hence India should be in a position to export manufactured pigments, finished paints and varnishes. And Andhra Desa is particularly more favourable to export 'Paints and Varnishes' being rich in its vast and varied paint material resources. Paint industries can be easily decentralised and run on cottage lines provided there is a central research laboratory to answer the requirements and needs of these small concerns.

2. Paints.

Paint is a suspension of a solid material in a liquid medium diluted to brush consistency. It is composed of the following ingredients. (*a*) Pigment, (*b*) Inert filler and Extender (*c*) Drier, (*d*) Drying oils and diluents.

(a) Pigments.

Pigment is characterised by its opacity, oil absorption, spreading power, and durabiltiy. Among the naturally occurring pigments in Andhra Desa may be mentioned ochres, umbers, siennas, iron oxide and graphite. Yellow ochres from Madhavaram and grey ochres from Nallakonda in Kurnool District could be worked into useful and cheap pigments. Semiochreous masses found on weathred schists and traps of Dharwar

age in the Bellary district are used to some extent as colour washes for house painting, the common colours being dull orange and drab. 'Along the western base of the Ramandrug section of the Sandur Hill group' wrote R. Bruce Foote, 'a vast quantity of intensely red earthy haematite lies thickly scattered. This also seems to be a very pure mineral and would yield a splendid pigment for the mere trouble of collecting and grinding it.' The occurrence of earths of the umber and sienna groups should be sought for in association with manganese ore of the lateritoid type in the Kodur range. These natural colours could be easily worked into useful pigments possessing strong staining power, brightness of tint and fineness of texture, being free from grit.

Graphite an essential component of black and grey paints and also of bronzes is mined in Bhadrachalam taluq, in Polavaram and Chodavaram divisions of Godavari district, in the neighbourhood of Bezwada and in Salur and Kasipuram of Vizagapatam district.

For the five years ending 1933 the imports of graphite for 'Paints and Colours' averaged 621 tons valued at Rs. 1,54,162. The average export price from Vizagapatam is Rs. 70 whereas the import price is as high as Rs. 250 a ton. Proper adaptation of modern methods of manufacture will easily prevent this drain from these parts.

Besides the natural pigment colours, suitable raw materials are available for the manufacture of white pigments such as white lead, zinc oxide, zinc sulphide, lithophone and timonox, and coloured pigments such

as red lead, Antimony vermillion, lemon and orange chromes, zinc chromes, chromium oxide, Guignet's green and Prussian blue.

White lead and red lead are manufactured from lead and its chemical compounds. Lead ore is reported in Jangamarajapalle, Lankamalai hills east of Nandialampet, and Nagasanipalle of Cuddapah district, in Karampudi of Guntur district and in Basavapuram of Kurnool district. Careful prospecting would reveal the extent of these deposits. White lead may be manufactured electrolytically if the Hydroelectric schemes in this area mature and power made available at 3 to 4 pies per unit. The lead ores contain about 65 to 75% lead. Zinc ore (smithsonite) associated with barytes, blende and galena has been also reported from the lead mines of Basavapuram. If adequate deposits of this ore are assured, pigments like zinc oxide, zinc sulphide and lithophone can be produced commercially. Timonox and Antimony vermillion can be produced from stibnite ore disseminated among the schists of the Sandur hills near Ramandrug, Bellary district and in the Nallamalai hills near Jangamarajapalle, Cuddapah district. Stibnite ore in these parts contains 50% Antimony. Daniels and Corey pointed out that stibnite ores can be successfully concentrated by floatation methods using creosote oils and sulphric acid.

Recently Dr. M. S. Krishnan of the Geological Survey of India reported on the occurrence of chromite ore in the Kondapalle hills in Kistna district. This will help in the production of sodium and potassium chromates and dichromates. Iron ore deposits in

Bellary, Cuddapah, Godavari, Kistna, Kurnool, Nellore and Vizagapatam easily enable us to produce Prussian blues. Various chromes are produced from salts of lead and zinc and chromates and dichromates of the alkali metals.

(b) Inert fillers and extenders.

Besides the pigments the next important component of paints is the inert filler and extender, otherwise called the "re-inforcing pigment". In the manufacture of mixed paints with the exception of enamel paint composed of zinc white and dammar varnish, every mixed paint contains an inert filler or extender, or else, the paint will not remain in a ready-to-use form, but will set hard and lose much of its value. The important extenders occurring in the Andhra areas are barytes, china clay, asbestine, silica, gypsum and slate powder, the first two serving as mineral bases for the manufacture of lake pigments.

Barytes, besides being an extender and a mineral base for lake pigments, is an important raw material for the manufacture of lithophone. The largest deposits in India occur in the following Andhra districts of the Madras Presidency: Dhone Taluq, Kurnool District; Pulivendla Taluq, Cuddapah District; Tadpatri Taluq, Anantapur District; Narravada, Nellore District. At Kottapalli (Cuddapah) it is reported that there are over 30,000 tons of barytes in the first 20 feet of depth. The Mutssukota deposit may contain 70,000 tons. Four veins have been found near Narijamupalle in Anantapur, the largest of which is from 3 to 11 ft. wide and has been traced for more than a mile along its strike.

Production figures for Madras and the whole of India are given below :—

Barytes : Production. (Long Tons)

Period.	Production.	
	Madras.	India
1918–22	9,191	10,075
1923–27	4,167	10,353
1928–32	15,022	22,254

The world's annual production of barytes is about 5,00,000 tons, most of it being consumed in the manufacture of lithophone. In India it is used mainly as a filler in paper and rubber industries. As India is importing lithophone to the extent of 620 tons annually valued at Rs 15,400, the possibilities for the manufacture of this imported pigment from the existing zinc ores and barytes which occur in the same localities may be given a serious consideration.

The inactivity of barytes and its low oil absorption places it in the front rank of importance as a diluent of pigments. It is the recognised standard for "reducing" white lead, zinc white or a combination of both of these white pigments. Barytes possesses little or no opacity, and is practically deficient in "killing" power. Hence it is possible to "reduce" such pigments as greens with barytes with little loss of purity of colour. To be useful as a "reducer" of white lead or zinc white, it must be free from iron oxide and other tints. The addition of

barytes to white lead makes the pigment more permanent, less likely to be attacked by acids, and free from discolouration than when it is used alone. It is believed that it gives greater body to the paint and makes it more resistant to the influence of weather.

The crude mineral (barytes) from the mine is finely ground, purified with hydrochloric acid and separated into grades of varying fineness and purity by levigation. These different grades are then filterpressed and dried. The final grading and removal of oversize particles is carried out by the Raymond system of grinding and air floatation such that the product passes through 200 mesh screen leaving no residue on it.

Considering the varied uses of barytes in other fields as well, (weighting the mud fluids of Petroleum oil wells) it provides a very fruitful field of investigation. Largest deposits of this mineral in India being distributed in Andhra disricts, the development of this industry should receive the closest attention of Andhra industrialists.

China clay, though of little value as a pigment in oil paints due to its transparency and high oil absorption value, has the desirable property of remaining in suspension and thus inhibiting the settlement of other pigments such as barytes, red lead etc. So it finds limited application in this direction. However its electro-negative character in aquous media befits it as ideal pigment in distempers. Besides it serves very well as a base for lake pigments suitable for printing inks and water paints and as a raw material for the production of ultramarine. In Andhra Desa these deposits are

reported to occur at Jaggampet, Godavari district and at Binnavole, Vizagapatam district.

Asbestos and asbestine which find limited application in the manufacture of paints occur near Brahmanapalle, Cuddapah district were thin veins of chrysotile asbestos occur in dolomitic limestones. Coulson investigated the asbestos deposits of the Cuddapah and Kurnool districts in 1932 and found that the Brahmanapalle and Lopatanutulu occurrences extend over a distance of 9½ miles with 3 ft. beds. Asbestos is used in the manufacture of fire-proof paints. Asbestine consisting of short fibres is a byproduct of asbestos industry. It is used mainly for addition to ready mixed flat paints to buoy up heavier pigments and prevent their rapid settling as flat paints are more liable to settlement than gloss paints on account of the low viscosity of the medium. It is also used in washable distempers and in the preparation of fillers.

Silica under the proprietory name silex is used to improve white lead paint. It can be employed as a substitute for barytes in all cases except where the high specific gravity of the latter is an advantage. Its crystalline structure confers "tooth" or "bite" to a smooth or soapy pigment, thus facilitating repainting. It forms an invaluable base in the preparation of wood fillers for filling up the grain of open-grained woods. It occurs in the form of quartz as a byproduct of the mica mines of Nellore district. Gypsum, used as an important extender in the manufacture of venetian red containing 15 to 40% ferric oxide and the rest gypsum, occurs fairly abundantly in the marine clays at

Santaravuru on the Buckingham canal. Slate powder, though of minor importance as a filler and extender is mainly used in the preparation of stopping and filling compositions for wood work, machinery etc. It is obtained as a byproduct of the slate industry of Cuddaph and Kurnool districts.

(c) Driers.

To enable the paint to dry quicker, inorganic substances like oxides and salts of lead, manganese, cobalt etc., and organic compounds like rosinates, linoleates, and naphthenates of the above metals are incorporated in the paint. These driers reduce the time of drying considerably from 48 hours to 3 to 8 hours. Lead and manganese ores being available these driers can be produced locally. The abundant occurrence of manganese ores (mainly psilomelane) in the Sandur state and Vizagapatam district and the reported occurrences in Kurnool district should enable the manufacture of manganese driers to satisfy the entire needs of India. The occurrence of lead ores have been referred to already.

(d) Drying oils and diluents.

The class of oils which the paint and varnish maker uses show the property of 'drying' in the air. The drying of a film of paint or varnish depends primarily on the nature of the vehicle. Linseed oil is the principal drying oil used in the manufacture of paints and varnishes. Tung, oiticaca, perilla, and soya bean oils and fish oils like menhaden oil are also used. Semi-drying oils such as niger seed and tobacco seed oils are useful under certain circumstances.

Among the class of drying oils linseed oil is the only one available in Andhra Desa though in limited quantities. The following figures indicate the growth of this crop in these districts.

District.		*Acreage.*
Bellary	...	2,027
Cuddapah	...	212
Kurnool	...	617
Nellore	...	139
W. Godavari	...	194
	Total	3,189

The annual production is 400 tons of linseed, the all-India figure being 4,50,000 tons. By proper Government measures the acreage under linseed can be easily increased. Semi-drying oils like niger seed and tobacco seed are, however, available adequately to compensate for the insufficiency in linseed oil production.

Castor oil when properly dehydrated displays the same drying properties as tung oil. Yet it is more amenable to control during polymerisation than natural tung oil. It is showing great potentialities in the manufacture of quick-drying paint and varnish. Isoline, a dehydrated castor oil, was reported to body three to four times as fast as linseed oil, a mechanical mixture of 40% dehydrated castor oil and 60% soya bean oil was said to dry a little faster than linseed oil. Castor crop is extensively cultivated in Guntur, Kurnool, Anantapur and Nellore districts producing annually about 11,000 tons of oil valued at Rs. 15·0 lakhs. Manufacture of dehydrated castor oil would greatly relieve the shortage

of linseed oil. Besides castor oil is used as a plasticiser in the manufacture of cellulose lacquors and varnishes.

3. Varnishes.

Varnishes classified as oil and spirit varnishes are composed of a resin either natural or synthetic dissolved in a drying oil or a volatile solvent which on drying leaves behind a bright glossy and transparent film on the surface to which it is applied. Besides the pigments, driers and drying oils already mentioned, other raw materials like shellac, white dammar and Gum arabic and solvents like Industrial alcohol are available in Andhra districts for the manufacture of varnishes. Nearly 35 tons of lac valued at Rs. 30,000 is produced annually in the Vizagapatam agency tracts including Jeypore. As plant hosts for lac insects are available there is ample scope for increased cultivation of lac. Industrial alcohol, a very important component of spirit varnishes, can be economically produced from molasses, a byproduct of the Sugar Industry of these parts.

4. Conclusion.

The above survey clearly demonstrates the rich resources of Paint and Varnish materials available in the Andhra districts. The commercial exploitation of these ores should be carried out rather cautiously being alive to the peculiar difficulties of these parts regarding finance, technique, organisation and marketing. With men of proper foresight, shrewd judgment and business ability, the initial difficulties that might face this industry can be easily overcome and a great and prosperous industry can be built up on stable foundations providing employment to a number of people in these districts.

Bibliography.

Periodicals.

1. Coulson, A. L., Mem. G. S. I. LXIV (1933 and 34) Parts I and II.
2. Fermor, L. L., Mem. G. S. I. XXXVII (1909) 192, 243, 992, 1038, 1045.
3. Foote, R. B., Mem. G. S. I. XVI (1879) 93.
4. Hamor, W. A., J. Ind. Eng. Chem. News Ed. 19 (1941) 12.
5. Jones, H. Cecil, Rec. G. S. I. XXXVI (1908), 233.
6. King, W., Mem. G. S. I. VIII (1872), 273, 276.
7. ,, Rec. G. S. I. XIX (1886), 155–6.
8. Mallet, F. R., Rec. G. S. I. XIV (1881), 196.
9. Morrell, R. S. & Phillips. E. O., J. Oil Col. Chemistry Asson. 23, 1940, 118.

Books.

10. Coggin Brown, Mineral Wealth of India, 1935.
11. Heaton, N., Outlines of Paint Technology, 1928.
12. Madras Industries Association—Is it Indian? 1940.
13. Mahadevan, C., An Outline of the Mineral Resources of Andhra Desa, 1940.
14. Morrell, R. S., Rubber, Resins, Paints, and Varnishes, 1920.
15. Toch, M., Chemistry and Technology of Paints, 1925.

Printed at Ananda Press, Madras.